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DISCUSSIONS BETWEEN ECONOMIC AGENTS: ANNIVERSARY SERIES



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**DISCUSSIONS BETWEEN ECONOMIC AGENTS:
ANNIVERSARY SERIES**

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PREFACE

The new subject of the series “Discussion Between Economic Agents” is the Anniversary Series. On the occasion of the 10th anniversary of IKSAD, I thought it appropriate to publish the book series under this name this year. The fact that the authors are from different fields has widened the scope of this book. In this book, the eighth book of the series, there are many current topics in primary fields such as logistics, business, economics, and the public. The econometric methods used are up-to-date and exemplary for the readers. There are eight valuable papers in the book. Let me discuss shortly about the articles.

In the first chapter of the book, Ozge DEMIRAL prepared a study entitled “Sectoral Production and Transport Carbon Pollution in High Logistics Performers.” The author used the CS-ARDL and CS-DL methods for 21 developed countries using data from 1976-2020. In the study, it is determined that increases in the real value-added per capita production of the industrial and service sectors lead to significant increases in transportation-related carbon intensity per capita and solutions are proposed in this framework.

In the second chapter, Emine Dilara AKTEKIN GOK and Hilal BUDAK BICER, in their work “Ecological Footprint and Economic Growth: Empirical Evidence EU-15 Countries,” aimed to learn whether there exists a relationship between ecological footprint and economic growth. In their study, the authors analyzed data from 15 European countries for the period 1992-2022. The CCE method was used to estimate the long-run coefficients. They concluded that renewable energy is an important determinant of environmental and economic sustainability.

In the third part of the book, Sefa KOCYIGIT, author of the study “The Economic and Social Determinants of Crime: A Panel Data Analysis of G7 Countries,” analyzed crime rate, inflation rate, unemployment rate, GDP per Capita, urbanization, social development index, and social welfare expenditures, which were obtained from the World Bank and OECD using annual data. The author used panel data algorithms to forecast the crime rate in G7 countries.

In the fourth chapter of the book, Abdullah AYDIN and Aziz BELLI conducted a study named “A General Discussion on the Local Governments Dimension of Public Entrepreneurship,” which aimed to provide information about the local governments' dimension of public entrepreneurship. In this context, it was emphasized that finding new solutions to new problems that put entrepreneurship at the center will be one of the most critical issues that will facilitate the work of local governments.

In the fifth chapter, Yasin OZKUTLU and Recep CICEK conducted a structural equation model using 51 questions formed from 91 scales by the US Department of Defense in the study named “The Effects of Performance-Based Logistics on Growth, Quality, and Efficiency: A Study in Turkish Automotive Industry.” The main objective of the research is to examine the effects of performance-based logistics used by the US Department of Defense in the maintenance and operation of defense industry projects on the logistics chain and the growth, quality, and productivity of Turkish vehicle supply industry enterprises. Thanks to the PBL application used in the study, it is possible to analyze and improve the logistics operations of the enterprises, while the data and information obtained for the analysis are also included. These findings help businesses

evaluate their current logistics performance and shape their future strategic decisions.

In the sixth chapter of the book, Erinc BAYRI prepared a study named “The Window Opening to the Sky of the Finance World: Financial Literacy and Behavioral Finance”. In his study, the author evaluates the effectiveness of financial literacy in influencing individuals' investment decisions. The study includes an assessment of financial literacy levels across countries and analyzes the extent to which individuals correctly answer questions designed to measure their financial knowledge, which types of questions they answer more accurately, and the reasons for inconsistencies in their answers. As a result, it is concluded that there is a positive correlation between individuals' financial literacy levels and their investment decisions.

In the seventh chapter Gamzenur COSKUN UZEL in her work called “Bitcoin and Macroeconomic Variables: An Econometric Approach to the German Economy”, aimed to analyse the relationship between cryptocurrency, economic growth, and interest rate using quarterly data for the period 2013Q1 -2023Q4. As a result, bidirectional causality was found, indicating that Bitcoin has high volatility in the German economy and is strongly affected by macroeconomic changes. Therefore, financial traders in the German market should diversify their portfolios and develop risk management strategies against these risks.

“The Relationship Between Renewable Energy Technologies, Energy Innovation, and CO₂: A Konya Bootstrap Causality Analysis” is the last chapter of the book. The authors, Kubra GÖGER and Sebastian Majewski discussed the concept of renewable energy technologies and explained the relationship

between energy innovation, CO₂, and technology. Using Konya Bootstrap Causality Analysis in their study, the authors obtained different results in E7 countries.

My sincere thanks to the authors for their dedication and contributions. All errors and references are the responsibility of the authors. I would also like to thank the IKSAD Publishing House managers and staff for their support during the publication of this book.

Prof. Dr. Okyay UCAN

CHAPTER 1

SECTORAL PRODUCTION AND TRANSPORT CARBON POLLUTION IN HIGH LOGISTICS PERFORMERS

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INTRODUCTION

Transport and logistics contribute to all economic activities and human welfare but remain among the top emitter industries. That is mainly because the world's transport networks and logistics systems still mostly use non-renewable fossil energy. This means that the worldwide rising transport activities such as shipment, aviation, roads, and railways mobilities that connect all countries through supply chains are accompanied by the ever-growing transport carbon emissions. Since there is no reason to expect a reduction in transport for the foreseeable future in the world, fossil energy use and relevant carbon emissions are projected to increase in the transport sector, unless a significant shift away from current fossil-dominant patterns of energy use is achieved (EDGAR, 2024).

At the same time, most countries, mainly developed countries, have recently come together and initiated passionate climate actions to ease the environmental harms of economic activities (UNFCCC, 2023; 2024). Consistently, many developed countries have recently slowed down the carbon intensity in some economic activities. However, the carbon pollution impacts of transport and logistics operations in these countries keep increasing rapidly without a peak (EDGAR, 2024).

Therefore, a better understanding of the associations between varied economic activities and transport-induced carbonization has important policy implications in developed countries, especially in high logistics performers. The existing literature has focused on sustainable transportation itself (Chapman, 2007; Georgatzi et al., 2020; Churchill et al., 2021, Awan et al., 2022) and paid little attention to the driving forces of other sectors on transport carbon emissions. Pointing out the research gap, this study examines the effects of real production (value-added) by agriculture, industry, and services on transport-induced carbon dioxide (CO₂) emissions in 21 developed countries (shown in Table 2) with high logistics performance. The study also considers environmental technologies patents, trade openness, energy prices, and

urban population. The study employs robust estimators to a panel dataset spanning from 1976 to 2020 and compares the short-run and the long-run elasticities of transport emissions.

1. GLOBAL CARBONIZATION AND LOGISTICS TRENDS

The increasing trends in economic growth together with the related production, trade, and consumption activities have been consuming a huge amount of energy, which is still dominated by fossil resources such as coal, oil, and natural gas. At the same time, some significant achievements in the renewable energy transition and decarbonization targets have been witnessed especially after the 2000s in some developed countries. However, the exceptional expansion of the logistics sector worldwide has remained leading to increases in fossil energy consumption and associated carbon emissions. These trends can be seen in Table 1. It shows that the power industry had the largest share in total fossil carbon emissions globally over time. The transport sector grew rapidly and had the second-highest share in fossil carbon emissions globally since the 1990s. During the 2005-2020 period, the sampled countries declined fossil carbon emissions considerably in all sectors except for transportation. Therefore, the transport sector continues threatening seriously the decarbonization trajectory of developed countries including the sampled advanced economies.

Table 1. Annual fossil CO₂ emissions by main sectors in the world and sampled-21 countries (million metric tons, period averages)

	Global			Sampled-21			Rest of the world		
	1976-1989 avg.	1990-2004 avg.	2005-2020 avg.	1976-1989 avg.	1990-2004 avg.	2005-2020 avg.	1976-1989 avg.	1990-2004 avg.	2005-2020 avg.
Power industry	5907	8800 (49)	12873 (46)	3090	4018 (30)	3951 (-2)	2816	4782 (70)	8917 (87)
Buildings	3338	3177 (-5)	3315 (4)	1687	1542 (-9)	1380 (-10)	1651	1635 (-1.0)	1939 (19)
Transport	3838	5352 (40)	7329 (37)	2191	2847 (30)	3012 (6)	1647	2505 (52)	4317 (72)
Other industries	5041	5032 (-0.2)	7540 (50)	2264	1909 (-16)	1708 (-11)	2777	3123 (13)	5816 (86)
Other sectors	2220	2454 (11)	3722 (52)	761	712 (-7)	645 (-9)	1459	1743 (20)	3082 (77)
Total	20342	24815 (22)	34780 (40)	9993	11028 (10)	10696 (-3)	10350	13788 (33)	24071 (75)

Note: Sectoral emissions may not sum to the total due to rounding. Values in () are the % change with respect to the previous period's average.

Source: EDGAR (2024).

On the other hand, knowing its importance for the integration into well-functioning global supply chains, countries have been trying to increase their international logistics performance to transport goods, commodities, and people promptly and reliably. From the developed countries' perspective, Table 2 shows overall international Logistics Performance Index (LPI) scores and the global ranks of the sampled countries for the years 2007, 2010, 2014, and 2018. These logistics metrics are based on custom transactions, infrastructure improvement, cross-border shipments, logistics competence and quality, timeliness, and tracking/tracing scores of the countries. The scores are collected based on the surveys of logistics professionals and key performance indicators assessing the actual speed of international trade (World Bank, 2024). As shown in Table 2, the sampled-21 countries are in the one-fourth top logistics scorers over time.

Table 2. International Logistics Indices (ILPI) of the sampled countries

Country	2007		2010		2014		2018	
	Overall LPI	Global rank	Overall LPI	Global rank	Overall LPI	Global rank	Overall LPI	Global rank
Australia	3.79	17	3.84	18	3.81	16	3.75	18
Austria	4.06	5	3.76	19	3.65	22	4.03	4
Belgium	3.89	12	3.94	9	4.04	3	4.04	3
Canada	3.92	10	3.87	14	3.86	12	3.73	20
Denmark	3.86	13	3.85	16	3.78	17	3.99	8
Finland	3.82	15	3.89	12	3.62	24	3.97	10
France	3.76	18	3.84	17	3.85	13	3.84	16
Germany	4.10	3	4.11	1	4.12	1	4.20	1
Ireland	3.91	11	3.89	11	3.87	11	3.51	29
Israel	3.21	33	3.41	31	3.26	41	3.31	37
Italy	3.58	22	3.64	22	3.69	20	3.74	19
Japan	4.02	6	3.97	7	3.91	10	4.03	5
Luxembourg	3.54	23	3.98	5	3.95	8	3.63	24
Netherlands	4.18	2	4.07	4	4.05	2	4.02	6
N. Zealand	3.75	19	3.65	21	3.64	23	3.88	15
Portugal	3.38	28	3.34	34	3.56	26	3.64	23
Spain	3.52	26	3.63	25	3.72	18	3.83	17
Sweden	4.08	4	4.08	3	3.96	6	4.05	2
Switzerland	4.02	7	3.97	6	3.84	14	3.90	13
The U.K.	3.99	9	3.95	8	4.01	4	3.99	9
The U.S.	3.84	14	3.86	15	3.92	9	3.89	14

Note: The numbers of the covered countries are 150 in 2007, 155 in 2010, 160 in 2014 and 2018.

Source: World Bank (2024). LPI Dataset. <https://lpi.worldbank.org/>

2. VARIABLES AND DATA

This study examines the effects of per capita real production (value-added) in agriculture, industry, and services sectors on per capita transport-induced fossil CO₂ emissions in 21 developed countries with high logistics performance. The study also considers environmental technologies per capita, trade openness, energy prices, and urban population to control for their impacts on transport-induced carbonization. Table 3 introduces the variables, as well as their indicators and measures.

Table 3. Variables

Indicator and measures	Variable	Data source
Fossil CO ₂ emissions from transport. Kilogram per capita	<i>TRCE</i>	EDGAR (2024) CO ₂ emissions database
Agricultural production. Value-added per capita in agricultural sectors.	<i>AGRP</i>	UNCTAD (2024) output and income database
Industrial production. Value-added per capita in industry sectors.	<i>INDP</i>	
Service production. Value-added per capita in services sectors.	<i>SERP</i>	
Total patents of all environmental technologies (all inventions). Number of patents per 1 million population.	<i>ETEC</i>	Own calculations based on OECD (2024) environment database
Trade openness. % share of exports and imports of goods and services in gross domestic product (GDP)	<i>TROP</i>	Own calculations based on UNCTAD (2024) output and income database
Energy prices. Energy consumer price index (CPI). 2015=100.	<i>ENPR</i>	OECD (2024) prices and purchasing power parities database
Urban population. Inhabitants living in urban areas. Thousand people	<i>UPOP</i>	Own calculations based on UNCTAD (2024) population database

Sectoral production variables are measured in real value-added terms as per capita United States dollars (USD) at constant (2015) prices. Sectoral categorization is based on the third revision of the International Standard Industrial Classification of All Economic Activities (ISIC). In this classification, agriculture (ISIC A-B) comprises agriculture, hunting, forestry, and fishing. Industry (ISIC C-F) consists of mining, manufacturing, utilities, and construction. Services (ISIC G-P) include wholesale, retail trade, restaurants/hotels, transport, storage, communications, and other service activities.

The development of environmental technologies (all inventions) is proxied by the number of total patents. To improve the statistical convenience, it is taken as per one million population, which hinders too small numbers and possible biases caused by population size

differences. Urbanization and population are proxied by a single variable of urban population, which better captures the impacts of inhabitants on transport emissions compared to the alternative population indicators.

3. METHODOLOGY

To know the basic distributional information about the data, firstly the variables' descriptive statistics and pairwise correlations are computed. Again, the learning of some pre-estimation diagnostics of variables and models is important to select a proper estimation strategy. Regarding this, secondly, the cross-country dependence (CD) of variables is inspected. The presence of external global shocks such as energy crises, pandemic lockdowns, and economic crises that spill over countries affects the levels of the measured data in different countries and thus causes CD. Given the ever-increasing economic and financial integration experiences of the selected countries, CD is expected inherently in this study's case.

Methodologically, some traditional techniques do not account for CD while some new tests consider CD. Thus, the negligence of CD may result in the selection of inefficient tests and produce invalid results that cause wrong inferences. To test the CD, the classic Lagrange Multiplier (LM) test (Breusch & Pagan, 1980) and bias-adjusted LM test (Pesaran et al., 2008) are among the most popular approaches. Moreover, a relatively newer CD test by Pesaran (2015) is useful to determine whether the CD process is weak in the construction of large panel data modeling.

Thirdly, the stationarity features of the data distributions are investigated through unit root tests. If CD was confirmed for variables, those unit root tests that are robust to CD such as the cross-sectionally augmented Im-Pesaran-Shin (CIPS) method (Pesaran, 2007) should be adopted.

During the model estimation, the estimators are selected depending on the stationarity and non-stationarity of the variables. If the model has variables with a unit root (non-stationarity) at level but without a unit root (stationarity) in their first difference terms, i.e., $I(1)$, the traditional estimation procedures lose efficiency. In this case, cointegration analyses are commonly conducted to explore the associations between $I(1)$ variables. However, when the variables are a mix of stationary, i.e., $I(0)$ and nonstationary, i.e., $I(1)$ processes, the cointegration results may be biased, and thus attained results may be unreliable. In this case, the CD-augmented version of the autoregressive distributed lag (CS-ARDL) modeling (Chudik et al., 2016) still produces reliable results. The CS-ARDL approach that is robust to heterogeneity, CD, and mixed order of integration features in data also has another advantage as it distinguishes elasticities between the short-run and long-run separately (Ditzen, 2021).

Additionally, for a methodological robustness check of the long-run estimates, the cross-sectionally augmented distributed lag (CS-DL) approach is a useful supplementary test. The performance of the CS-DL approach is often superior to the alternative panel ARDL estimates, particularly when the time dimension of the panel is moderately large between 30 and 50 (Chudik et al., 2016; Ditzen, 2021), which fits well with this study's case. Consistently, in the final step of the study's analysis, the elasticities of the variables are calculated by conducting the CS-ARDL and CS-DL estimators.

4. RESULTS AND IMPLICATIONS

Descriptive statistics and correlations are provided in Table 4. The mean of *TRCE* is about 2.7 tons per capita and it is minimum at 585 kg (Portugal's value in 1976) and reaches the maximum at about 15.7 tons (Luxembourg's 2005 value). The higher mean value of *SERP* is consistent with the tertiarization processes (shifting from the agricultural and industrial sectors to the service sectors in economic

activities) in developed countries. Correlation coefficients show that *TRCE* and *INDP* are highly (≥ 0.70) and positively correlated with *SERP*. Similarly, the correlation between *SERP* and *TROP* is high and positive.

Table 4. Descriptive statistics and correlations (non-log)

	Descriptive statistics							
	<i>TRCE</i>	<i>AGRP</i>	<i>INDP</i>	<i>SERP</i>	<i>ETEC</i>	<i>TROP</i>	<i>ENPR</i>	<i>UPOP</i>
Mean	2675	584	8799	25246	251	68	65	30957
Max.	15740	1824	26740	88658	749	361	127	274188
Min.	585	114	2211	5655	0.94	10	0.01	278
Std.dev.	1939	312	3613	13458	199	54	29	49313
	Pearson correlations							
	<i>TRCE</i>	<i>AGRP</i>	<i>INDP</i>	<i>SERP</i>	<i>ETEC</i>	<i>TROP</i>	<i>ENPR</i>	<i>UPOP</i>
<i>TRCE</i>	1	0.04	0.28	0.72	0.09	0.55	0.18	0.18
<i>AGRP</i>		1	0.09	-0.04	-0.10	-0.17	0.03	-0.22
<i>INDP</i>			1	0.72	0.60	0.40	0.43	0.003
<i>SERP</i>				1	0.47	0.70	0.48	0.06
<i>ETEC</i>					1	0.17	0.57	0.23
<i>TROP</i>						1	0.38	-0.35
<i>ENPR</i>							1	0.14
<i>UPOP</i>								1

In the analysis, the data series are transformed to natural logarithmic (shown in lower cases) terms to have elasticity forms of the estimated coefficients. The results from the CD tests conducted for both detrended and trended processes are provided in Table 5. The test results consistently reveal that all variables have CD. This feature indicates the necessity of the selection of methods that consider CD in further analyses.

The stationarity results from the CIPS unit root test again applied for both detrended and trended processes are shown in Table 6.

Table 5. Results from cross-sectional dependence tests

	Detrended			
	<i>trce</i>	<i>agrp</i>	<i>indp</i>	<i>serp</i>
Breusch-Pagan LM	305.68***	242.91*	455.94***	317.71***
Bias-adjusted LM	310.76***	274.65***	271.13***	346.71***
Pesaran (2015)	68.32***	10.18***	77.71***	93.64***
	<i>etec</i>	<i>trop</i>	<i>enpr</i>	<i>upop</i>
Breusch-Pagan LM	379.21***	384.69***	504.65***	344.46***
Bias-adjusted LM	325.98***	354.04***	117.99***	372.07***
Pesaran (2015)	86.20***	93.45***	87.55***	85.86***
	Trended			
	<i>trce</i>	<i>agrp</i>	<i>indp</i>	<i>serp</i>
Breusch-Pagan LM	334.53***	269.05***	472.30***	341.47***
Bias-adjusted LM	303.23***	271.52***	264.44***	336.78***
	<i>etec</i>	<i>trop</i>	<i>enpr</i>	<i>upop</i>
Breusch-Pagan LM	393.44***	380.59***	496.95***	347.37***
Bias-adjusted LM	317.94***	344.46***	121.28***	361.86***

Notes: ***: $p < 0.01$, **: $p < 0.05$, * $p < 0.10$.

Table 6: Results from CIPS unit root test

	Level		First difference		Inference
	Detrended	Trended	Detrended	Trended	
<i>trce</i>	-1.99	-2.47	-4.58***	-4.06***	I(1)
<i>agrp</i>	-2.00	-2.48	-4.65***	-4.87***	I(1)
<i>indp</i>	-2.22**	-2.66*	-4.13***	-3.75***	I(0)
<i>serp</i>	-2.17*	-2.43	-3.60***	-3.11***	Not I(2)
<i>etec</i>	-2.75***	-2.92***	-3.79***	-3.54***	I(0)
<i>trop</i>	-1.59	-1.86	-4.44***	-4.26***	I(1)
<i>enpr</i>	-2.55***	-2.81**	-2.86***	-2.93***	I(0)
<i>upop</i>	-1.86	-3.33***	-2.60***	-3.25***	Not I(2)

Note: ***: $p < 0.01$, **: $p < 0.05$, * $p < 0.10$.

It can be inferred from the results that the variable set is a mix of the I(0) and I(1) processes, but not I(2). Together with the presence of the CD and country heterogeneity, this feature prompts the use of the CS-ARDL and CS-DL models to estimate the elasticities. The results of the model estimates are represented in Table 7.

Table 7. Results from CS-ARDL and CS-DL estimates (dependent variable is *trce*)

	CS-ARDL estimates		CS-DL estimates
	Short-run	Long-run	
Lagged <i>trce</i>	-0.692*** [0.05]	---	---
<i>agrp</i>	-0.014 [0.03]	-0.005 [0.02]	0.018 [0.03]
<i>indp</i>	0.223*** [0.07]	0.126*** [0.04]	0.056 [0.04]
<i>serp</i>	0.404*** [0.15]	0.236*** [0.09]	0.164** [0.08]
<i>etec</i>	0.001 [0.02]	-0.00003 [0.01]	0.005 [0.01]
<i>trop</i>	0.192** [0.09]	0.122** [0.05]	0.184*** [0.06]
<i>enpr</i>	-0.195*** [0.05]	-0.126*** [0.03]	-0.084*** [0.01]
<i>upop</i>	0.231 [0.04]	0.057 [0.31]	0.265** [0.12]
F-test (p>F)	1.95***		1.56***
R ²	0.38		0.68
R ² (MG)	0.66		0.31
RMSE	0.02		0.03
Model CD stat.	1.79*		5.55***

Note: Standard errors are in []. ***: $p < 0.01$, **: $p < 0.05$, * $p < 0.10$.

It is commonly argued that agricultural activities may lead to increases in carbon emissions directly, albeit with some decoupling trends in developed countries (Bennetzen et al., 2016). As agricultural activities also need and use transport services, this study proposed that agricultural production increased transport-induced carbonization, as well. However, results reveal that changes in agricultural production do not have any significant impact on transport-driven fossil carbon emissions for both the short-run and the long-run. This can be partly explained by the shrinking trends in agricultural activities and relatively weaker linkages between the transport and agricultural sectors of the sampled developed countries.

Industry is the key carbon emitter sector even in deindustrializing developed countries. From the intersectoral perspective, the results supported that industrial production also increased the transport carbon emissions in both the short-run and the long-run. The CS-ARDL results indicate specifically that a one-dollar real increase in per capita industry value-added brings an extra 0.22 kg (in the short-run) and 0.13 kg (in the long-run) of fossil CO₂ emissions in the transport sector. The sampled countries have recorded significant improvement in green

industry trajectories. However, they need to consider the carbon leakages from industry to transport and logistics activities to ease the overall carbon intensity.

Ever-improving service operations especially in developed countries are closely linked to transport activities. Therefore, the indirect carbonization impacts of service production on transport carbon emissions are strongly expected. The results clearly supported this argument that the highest positive elasticities were found for the service sector. The point estimation results from the CS-ARDL method reveal that a one-dollar real increase in per capita services value-added causes an extra 0.40 kg (in the short-run) and 0.24 kg (in the long-run) of fossil CO₂ emissions in the transport sector. The CS-DL estimates also supported the strong coupling link between tertiarization and transport carbon pollution in the long-run. This evidence, once again, highlights the importance of clean energy transition and sustainable transport modes which are the key facilitators of the services sector.

Both policymakers and researchers are interested in the association between climate change technologies and environmental pollution (Bel & Joseph, 2018). The sampled developed countries are increasingly investing in environmental technologies. However, the results indicate that the level of the environmental technology inventions is not enough to be able to affect the transport carbon emissions. In fact, new environmental technologies are mostly invented in industry sectors. New inventions in the transport sectors mainly focus on time efficiency and cost reduction. Thus, limited environmental inventions should be increased and redesigned for energy and carbon efficiency in the sampled countries.

Transport activities and logistics operations are important contents of global supply chains in international trade. For the sampled high logistics performer countries, therefore, the increasing trade activities are expected to intensify the transport activities and related carbon emissions. The results supported this premise consistently that

trade openness globalizes local emissions through vitalized transport and logistics operations. This evidence implies that developed countries need to lead to green trade mechanisms and sustainable supply chains in the world trade system. By doing so, these countries need to establish and implement efficient carbon adjustment systems in the customs to hinder the cross-border carbon leakages driven by international trade.

Among the considered variables, energy price is the only factor negatively associated with transport carbon emissions. This finding asserts that arranging the energy prices may be an efficient way to decrease transport carbon emissions. Letting the energy prices increase may motivate transport agents to better find ways to save energy, which helps carbonization mitigation. Therefore, the examined countries should consider stopping fossil energy subsidies and rather putting extra taxes on the use of fossil energy. To ease the economic costs of energy inflation, these initiatives need to be accompanied by some policy actions to increase the cheap availability (like fossil energy resources) of renewable energy resources.

Transport activities are crucial for increasing the welfare of people. The results from the CS-DL estimates revealed that the increasing urban population had some carbonization forces for the transport sector in the long-run. From the urban society perspective, the environmental awareness of the increasing urban population should be increased. Accordingly, policymakers in the sampled countries should accelerate the sustainable transportation projects that include environmentally-friendly smart cities, electric car use, commuting-shortening infrastructures, carpooling, flexible working hours, smart traffic lighting, better bicycle and electric bike roads, electric-powered public transportation, higher transport energy standards, etc. All these micro-level and macro-level measures will help in preventing the persistent rise in transport-related carbon emissions.

This study focused on the impacts of sectoral productions, together with some important factors, on transport-induced fossil carbon emissions. However, further researchers should know that these variables do not cover the all factors determining transport-induced carbon emissions. Thus, new studies with different indicators and alternate measures will enrich this study's results.

SUMMARY

Taking a long panel dataset of 21 developed countries with high logistics performance, this study employed robust analysis techniques and found some significant evidence: The expansions in the industrial and services sectors' per capita real value-added productions lead to significant increases in per capita transport-induced carbon intensity. Although these links weaken in the long-run, which indicates a promising improvement in sustainable service and industry production for the future, trade openness threatens this green trajectory. Moreover, the increasing inventions in environmental technologies yet do not help in the mitigation of transport carbon emissions. Among the considered variables, energy inflation is the only factor with a significant negative association with transport-driven carbonization. Therefore, along with the improvement of green production technologies and non-fossil energy transition in all sectors, countries alternatively may include the environmental costs into the energy prices. The economic costs of the rising energy inflation and declining trade competitiveness may be compensated by increasing the availabilities of cheaper renewable energy and better green transport and logistics infrastructures.

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CHAPTER 2

ECOLOGICAL FOOTPRINT AND ECONOMIC GROWTH: EMPIRICAL EVIDENCE EU-15 COUNTRIES

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INTRODUCTION

Ecological footprint shows the amount of natural resources that can be produced in the same period of time and whether natural resources are within the limits of self-renewal. This situation arises as a result of human activities and shows the amount of use and destruction of resources in the world. Determining the relationship between ecological footprint and economic growth draws attention to environmental awareness. Economic growth is an important target among basic macroeconomic indicators. The importance given to sustainability and social welfare is increasing with economic growth in economic activities. Ensuring economic growth together with a sustainable environmental understanding has become the main goal. A quality and sustainable environment is considered an indispensable condition for social welfare. Increasing awareness about the environment has led to the reconsideration of production and consumption functions in the use of scarce resources. Environment and sustainability issues are taken into account when establishing economic growth targets.

In this study, it is aimed to examine the relationship between ecological footprint and economic growth using data for the period 1992-2022 for EU-15 Countries. For this purpose, dynamic panel data analysis methods have been applied. The following sections of the study were created as follows. In the first chapter, the ecological footprint and economic growth literature is summarized in terms of theoretical and empirical results. In the second part, using the ecological footprint variable to represent the environment, the relationship between ecological footprint and economic growth was analyzed using panel data methods for the data of EU-15 countries for the period between 1992 and 2022. In the results section, the findings obtained in the analysis are included.

1.LITERATUR REVIEW

Sustainable economic growth is achieved by acting with environmental awareness in production and consumption activities. Studies addressing decisions regarding the use of renewable energy and reducing carbon emissions and the steps taken in this direction are frequently included in the literature. It is known that environmental sustainability and green growth are important in terms of the type of energy used and technology within the scope of sustainability of economic growth (Acemoğlu et al., 2012; Dike and Sam Dike, 2016; Lu, 2017; Lee, 2019; Kasztelan, 2017). Sustainable economic growth is effectively achieved through the use of renewable energy and environmental technologies (Aghion et al., 2016).

The effects of economic growth along with increasing sensitivity and awareness in protecting environmental quality are discussed. Economic growth should be evaluated on the axis of environmental sustainability as well as quantity. Studies in the national and international literature that test the ECI (Environmental Kuznets Curve) Hypothesis, which examines the relationship between economic growth and environmental pollution, remain important. Among these studies, Grossman and Krueger (1991) examined the relationship between per capita income and environmental quality and concluded that there was an inverted U relationship. There are many studies examining the ECI Hypothesis in different periods and country groups, stating that the increase in economic growth causes a negative impact on environmental quality and that it will turn positive after a certain income level (Sarısoy and Yıldız, 2013; Li et al., 2016; Lu et al., 2017; Ulucak and Koçak, 2018).

The relationship between environment and economic growth attracts attention in the context of economic sustainability and effective use of resources. Dell et al. (2008), as a result of the study examining the effect of climate changes on economic growth for 136 countries, found that the increase in temperature negatively affects economic growth in

poor countries and affects it to a lesser extent in rich countries. Koçak and Ulucak (2019) examined the period 1990-2014 in their study examining the relationship between environmental pollution and economic growth for 29 OECD countries. As a result of the analysis, it was determined that the Environmental Kuznets curve Hypothesis is not valid. Mensah et al. (2019) examined the relationship between technological innovation and green growth for 28 OECD countries for the period between 2000 and 2014. As a result of the study, it was determined that climate change technologies in energy production negatively affect green growth in OECD economies and that it is necessary to evaluate them as an industry. In their study where Danish and Ulucak (2020) examined the impact of environmental technologies on green growth, taking into account the use of renewable and non-renewable energy for BRICS countries, it was concluded that environmental technologies positively affect the concept of green growth.

Hassan et al (2019) examined the impact of human capital and economic growth on the ecological footprint. For Pakistan, it has been concluded that economic growth increases the ecological footprint and human capital reduces the ecological footprint in the short term. Udemba et al. (2020) concluded that economic growth for Nigeria causes both energy use and ecological footprint. Ansari et al (2021) examined the impact of renewable energy and globalization on the ecological footprint for the countries that consume the most renewable energy. While it increases its ecological footprint with economic growth and non-renewable energy consumption in the long term, It was concluded that renewable energy consumption, globalization and urbanization reduce the ecological footprint. Li et al (2022) examined the relationship between urbanization, energy use and environment for a large panel using data from 120 countries. The study concluded that the use of renewable energy promotes economic growth and contributes positively to the environment.

2. ECONOMETRIC ANALYSIS

2.1. Dataset and Methodology

In this study, the relationship between ecological footprint and economic sustainable future was examined with data for the period between 1992 and 2022 for EU-15 countries. Explanatory information about the data set and variables used is given in Table 1.

Table 1: Variables of Analysis

Variable	Symbol	Definition	Source
Ecological Footprint	EF	Global hectares per person	Global Footprint Network (2024)
Economic Growth	GDP	GDP per capita in constant 2010 US\$	World Bank (2024)
Renewable Energy Consumption	RC	Renewable energy consumption per capita (kWh)	BP (2024)
Urbanization	U	Urban population (% of total population)	World Bank (2024)

The relationship between ecological footprint and economic growth is examined with the variables shown in Table 1. To examine this relationship, first logarithmic transformations of the variables were made.

The model of the study was created as follows, based on the Köseoğlu et al. (2022) study:

$$\ln EF_{i,t} = \beta_0 + \beta_1 \ln GDP_{i,t} + \beta_2 \ln RC_{i,t} + \beta_3 \ln U_{i,t} + \varepsilon_{i,t} \quad (1)$$

where $\beta_0 \dots \beta_3$ are the unknown parameters to be estimated, t indicates the time period and $i = 1, 2 \dots N$ represents cross sections in panel, consisting of EU-15 countries and lastly ε is the error term.

2.2. Method

In this study, dynamic panel econometric estimations were made with the data set of EU-15 countries between 1992 and 2022. Panel data analysis is created for t time and n cross sections. This makes it possible to see group and time effects in the analysis.

The methodological steps of this study are as follows: The analysis begins with investigating the stationarity of the panel series. There are two generations of panel unit root tests in the literature to examine stationarity. While the first of these tests assumes cross-sectional independence, the second takes cross-sectional dependence into account (Baltagi and Pesaran 2007). Therefore, to determine an appropriate unit root test, the panel variable series is first checked for cross-sectional dependence. To decide whether cross-sectional dependence exists or not, Breusch and Pagan's (1980) LM test and LM_{adj} tests developed by Pesaran et al. (2008) was used. After determining the existence of cross-section dependence, stationarity is checked with second generation panel unit root tests (Baltagi, 2008: 284; Nazlıoğlu, 2010: 142). To determine whether the series contained a unit root, the CADF panel unit root test recommended by Pesaran (2007) was used. The CADF test provides results on unit root statistics for individual countries. This test gives reliable results because it takes into account both heterogeneity and cross-sectional dependence. Since the variables used in the research are stationary at their first differences, the analysis proceeds within the framework of cointegration. Whether there is a cointegration relationship is analyzed with the LM cointegration test developed by Westerlund and Edgerton (2007), which is one of the second generation panel cointegration tests that allows cross-section dependence. LM cointegration test is based on the Lagrange multiplier test proposed by McCoskey and Kao (1998) (Türkmen, 2019). After the cointegration analysis confirms the existence of long-term relationships between the variables in the models, cointegration coefficients that take into account both heterogeneity and cross-sectional dependence are estimated. Long-

term coefficients were estimated with the Common Correlated Effects (CCE) method proposed by Pesaran (2006), which takes cross-sectional dependence and heterogeneity into account together.

2.3. Results

The concept of stationarity is important in choosing the appropriate analysis method in the study. The stationarity result plays a decisive role in the selection of panel unit root tests. Panel unit root tests are divided into two groups as two generations. While first generation tests allow cross-section dependence, first generation unit root tests do not allow this. In this regard, the cross-sectional dependency of each variable is examined and it is decided which unit root test will be applied. We use two cross-sectional dependence tests in this study: the Breusch and Pagan LM test (1980) and the Pesaran, Ullah, and Yamagata (PUY) bias-adjusted LM test (2008). These tests are based on the null hypothesis of no cross-sectional dependence. Table 2 presents the cross-sectional dependency test results.

Table 2. Cross-Sectional Dependency Tests

	<i>lnEF</i>	<i>lnGDP</i>	<i>lnRC</i>	<i>lnU</i>
Breusch-Pagan LM Test	1766.793 ^a (0.000)	2533.070 ^a (0.000)	2181.351 ^a (0.000)	2912.468 ^a (0.006)
PUY Bias-Adjusted LM Test	114.424 ^a (0.000)	167.302 ^a (0.000)	143.031 ^a (0.000)	193.483 ^a (0.000)

Notes: P-values are presented in the parentheses. a show the statistical significance at the 1 percent level.

Table 2 presents the results of the cross-sectional dependence tests. Cross-sectional dependence test results reject the null hypothesis that there is no cross-sectional dependence. This situation shows the existence of cross-sectional dependence. Accordingly, we continue our

analysis with the second generation panel unit root test, which takes cross-sectional dependence into account.

To determine whether the series contain unit roots, we used the CADF panel unit root test suggested by Pesaran (2007). The CADF test provides results for unit root statistics for individual countries. This test gives reliable results because it takes into account both heterogeneity and cross-sectional dependence (Dogan and Seker, 2016). Table 3 shows the panel unit root test results.

Table 3. Panel Unit Root Test

	Level	First Difference
<i>lnEF</i>	-1.971	-4.135 ^a
<i>lnGDP</i>	-1.451	--3.230 ^a
<i>lnRC</i>	-1.915	-4.581 ^a
<i>lnU</i>	-1.521	-2.548 ^a

Notes: P-values are presented in the parentheses. a show the statistical significance at the 1 percent level.

According to the panel unit root test results, all series become stationary at their first differences, that is, all series contain unit roots. This situation allows us to apply the cointegration test. To decide which cointegration test to apply in the study, we first examine the slope homogeneity and cross-section dependence of the models. We use the Breusch-Pagan LM and PUY bias-adjusted LM tests to test the cross-sectional dependence of the model. To test the homogeneity of the model, we use Pesaran and Yamagata's (2008) slope homogeneity test. Table 4 reports cross-section dependence and slope homogeneity results for the model.

Table 4. Model Specification and Cointegration Test

	Model	
Slope Homogeneity	Delta-Tilde	27.279 ^a (0.000)
	Adjusted Delta-Tilde	29.787 ^a (0.000)
Cross-Sectional Dependency	Breusch-Pagan LM	300.3 ^a (0.000)
	PUY Bias-Adjusted LM	36.38 ^a (0.000)

Notes: P-values are presented in the parentheses. a show the statistical significance at the 1 percent level.

The results shown in Table 4 show that the model is heterogeneous and contains cross-sectional dependence. These results lead to the use of second generation cointegration methods when performing cointegration analysis. Therefore, to determine whether the variables are cointegrated, we apply Westerlund and Edgerton's (2007) panel cointegration test. This cointegration test takes into account both heterogeneity and cross-sectional dependence. Table 5 shows the cointegration test results.

Table 5: Westerlund (2007) Cointegration Test Results

	LM Statistics	Bootstrap p-value
LM_N⁺	1.131	0.972

The cointegration results shown in Table 5 show that there are long-term cointegration relationships between the variables. The existence of the cointegration relationship allows us to estimate the

cointegration coefficients. Cointegration coefficients were estimated using the Common Correlated Effects (CCE) estimator developed by Pesaran (2006). The results obtained from the cointegration coefficients are shown in Table 6.

Table 6: Cointegration Coefficients Estimate (CCE)

CCE		
Variable	Coefficient	p-value
<i>lnGDP</i>	0.614	0.000 ^a
<i>lnRC</i>	-0.038	0.090 ^c
<i>lnU</i>	-1.446	0.153

Notes: P-values are presented in the parentheses. a and c show the statistical significance at the 1 and 10 percent levels, respectively.

The CCE test applied within the scope of cointegration coefficient estimation shows that a 1% increase in economic growth will lead to a 0.614% increase in the ecological footprint and an increase in renewable energy will reduce the ecological footprint by 0.038%. It shows that urbanization is statistically insignificant.

Conclusion

Limited natural resources and rapid increase in environmental pollution is a problem recognized throughout the world. Policy makers attach importance to ensuring environmental sustainability. This study examines the relationship between ecological footprint and economic growth for the EU-15 country group covering the period 1992-2022. In the analysis used in the study, cross-sectional dependence, panel unit root tests and panel cointegration tests were applied. The results of cross-section dependence tests showed that all variables in the same cross-section are dependent on each other. The existence of cross-sectional dependence revealed that the second generation unit root test should be

used in the study. Panel unit root test results showed that the variables subject to analysis were stationary in their first differences. This situation revealed that the panel cointegration test can be applied. Panel cointegration test results show that there is a long-term relationship between the variables subject to analysis. In the last stage of the analysis, long-run coefficients were estimated based on the CCE estimator, which is the cointegration coefficients estimator.

Long-term estimates show that a 1% increase in economic growth will lead to a 0.614% increase in ecological footprint. The ecological footprint represents the impact of businesses, firms and people on the environment. The increase in economic growth increases economic activities and causes environmental degradation. Therefore, economic growth is shown as one of the main causes of environmental pollution. In this context, renewable energy is expressed as an important solution in terms of both environmental sustainability and economic sustainability. The findings we obtained within the scope of the study show that the increase in renewable energy will reduce the ecological footprint by 0.038%. Although EU-15 countries have made significant progress in the use of renewable energy, the targets have not been fully achieved. The findings obtained in this study, which was conducted to examine the relationship between climate change and an economically sustainable future for the EU-15 country group, may provide important clues for future studies.

SUMMARY

Economic growth is an important target among basic macroeconomic indicators. The importance given to sustainability and social welfare increases with economic growth in economic activities. Ensuring economic growth with a sustainable environmental understanding has become the main goal. Determining the relationship between ecological footprint and economic growth draws attention to

environmental awareness. Environment and sustainability issues are taken into account when determining economic growth targets.

This study aims to examine the relationship between ecological footprint and economic growth using data for the period 1992-2022 for EU-15 Countries. For this purpose, panel data analysis method was applied. In the analysis used in the study, cross-section dependence, panel unit root tests and panel cointegration tests were applied. The results of cross-sectional dependency tests showed that all variables in the same cross-section were interdependent and the second generation unit root test was used. Panel cointegration test results show that there is a long-term relationship between the variables subject to analysis. In the last stage of the analysis, long-term coefficients were estimated based on the CCE estimator, which is the cointegration coefficient estimator.

Long-term projections show that a 1% increase in economic growth will lead to a 0.614% increase in ecological footprint. Increasing economic growth increases economic activities and causes environmental degradation. For this reason, economic growth is shown as one of the main causes of environmental pollution. In this context, it is stated that renewable energy is an important solution in terms of both environmental sustainability and economic sustainability.

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CHAPTER 3

THE ECONOMIC AND SOCIAL DETERMINANTS OF CRIME: A PANEL DATA ANALYSIS OF G7 COUNTRIES

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INTRODUCTION

Crime has been a universal issue faced by societies throughout history. The manifestation of crime in various periods, cultures, and geographies complicates its definition. To understand the causes of crime, economic, social, and cultural factors are examined in depth. In this context, research on the economics of crime contributes to the development of effective policies to combat crime by analyzing its economic determinants.

This study examines the relationship between crime rates and economic indicators in G7 countries. The G7 countries, with their high levels of economic development and diverse socio-economic structures, serve as a significant example for such research. Using panel data analysis, the relationships between economic variables and crime rates have been evaluated in detail.

The aim of the research is to understand the dynamics of crime in G7 countries and to determine the impact of economic factors on crime. The study's capacity to generalize its results is limited by the constraints of the dataset. Additionally, focusing solely on specific economic indicators excludes other potential determinants of crime, and the results cannot be generalized to countries outside the G7. Due to the nature of panel data analysis, causality cannot be definitively established, and the findings are interpreted at the level of correlation.

1. THEORY AND LITERATURE

The economics of crime is based on the assumption that individuals make rational decisions based on economic incentives and costs. Theoretical studies in this field utilize economic models to explain criminal behavior and identify factors influencing crime rates. The literature has extensively examined the impacts of variables such as income level, unemployment, education level, and economic crises on crime rates.

Crime refers to acts of violation and aggression against the norms accepted by societies, threatening the safety of individuals and communities (Ayhan & Çubukçu, 2007). The emergence of crime is influenced by environmental, cultural, economic, and psychological factors. Understanding the causes and types of crime requires interdisciplinary approaches. Economic instability and social inequalities increase crime rates. The World Youth Report (2003) notes that since the 1970s, neoliberal policies have transformed poverty into a social crime issue. Reductions in social spending have led to increased poverty and rising crime rates (Gülcü, 2023). In this context, research in the economics of crime contributes to developing effective policies by analyzing the economic determinants of crime.

Since the 19th century, published crime statistics have detailed the relationship between crime, economic conditions, and poverty. Plato noted that hunger and poverty are at the root of crime (Platon, 2002). Modern research shows that economic instability and social inequalities increase crime rates. Interest in the concept of crime among economists is relatively new and is typically addressed within the framework of welfare economics (Dilek, 2017). These studies investigate why crime rates are high in certain regions and the factors influencing these tendencies (Aktaş & Nalçacı, 2022).

The economic theory of crime developed by Becker (1968) explains how individuals' tendencies to commit crimes are shaped by economic incentives and penalties, based on rational decision-making. Using data from the United States in 1965, this theory posits that individuals with higher incomes have lower tendencies to commit crimes. This theoretical model is considered a pioneering approach in analyzing the concept of crime from an economic perspective.

Ehrlich (1973), examining interstate crime rates in the United States, found a positive relationship between income inequality and property crimes, emphasizing the deterrent effect of the law. Similarly, Becker argues that individuals' tendencies to commit crimes are shaped

by rational decisions based on economic incentives and penalties. Both studies have made significant contributions to the literature by deeply analyzing the relationship between economic factors and criminal behavior.

Economic factors underpin crimes such as theft, fraud, and looting. Economic hardships, unemployment, and poverty increase the propensity for these types of crimes. Economic injustices and social inequalities raise crime rates, leading to societal unrest. In this context, recent studies examining the impact of economic factors on crime are crucial. The literature review section will analyze current research in this area to assess the dynamics of the economics of crime.

Table 1. Selected International Studies Based on Economic Variables

Authors and Year	Title	Research Topic	Dataset and Period	Methodology	Key Findings	Comments
Becker (1968)	Crime and Punishment	Economic theory of crime	USA, 1965	Economic Theory	Higher-income individuals are less likely to commit crimes.	Economic incentives and penalties influence criminal behavior.
Ehrlich (1973)	Participation in Illegitimate Activities	Income inequality and property crimes	USA, interstate index crimes	Econometric Analysis	Positive relationship between income inequality and property crimes.	Law enforcement has a deterrent effect.
Witte and Tauchen (1994)	Work and Crime	Relationship between unemployment and crime	USA, Philadelphia	Panel Regression Analysis	Positive relationship between unemployment and crime.	Theoretical views differ from empirical results.
Tsushima (1996)	Economic Structure and Crime	Relationship between unemployment and theft	Japan, 1986-1988	Multiple Regression Analysis	Positive relationship between unemployment	Economic incentives and penalties

					ment and theft.	influence crime rates.
Levitt (1998)	Why Do Increased Arrest Rates Appear to Reduce Crime	Education spending and theft crimes	USA, 1970-1992	Regression Analysis	Education spending increases theft crime rates.	Positive relationship between population growth and crime rates.
Raphael and Winter-Ember (2001)	Identifying the Effect of Unemployment on Crime	Income reduction and property crimes	USA, 50 states	Panel Data Analysis	Income reduction increases the likelihood of committing crimes.	Economic incentives and penalties are significant.
Fajnzylber, Lederman and Loayza (2002)	What Causes Violent Crime?	Relationship between income and theft crime	USA, 1970-1994	Panel Data Analysis	Positive relationship between income and theft.	Economic conditions affect crime rates.
Soares (2004)	Development, Crime, and Punishment	Impact of education level on theft crime	USA, 1975-1994	Panel Regression Analysis	Higher education levels reduce theft crimes.	Increase in police numbers raises theft incidents.
Levitt (2004)	Understanding Why Crime Fell in the 1990s	Reasons for the decline in crime rates	USA, 1973-2001	Time Series Analysis	Increased police numbers reduce crime rates.	Economic and social factors considered.
Buonanno and Montolià (2008)	Identifying the Socio-Economic and Demographic Determinants of Crime across Spanish Provinces	Relationship between per capita income and crime	Spain, 1993-1999	Panel Data Analysis	Increase in income reduces property crimes.	Economic conditions affect crime rates.

Ata (2011)	Relationship between Wages, Unemployment, and Crime	Relationship between unemployment and theft crime rates	Europe, 2008	Regression Analysis	Positive relationship between unemployment and theft.	Socio-economic factors considered.
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Table 2. Selected International Studies on Social and Behavioral Variables

Authors and Year	Title	Research Topic	Dataset and Period	Methodology	Key Findings	Comments
Zimbardo (1970)	The Human Choice	Control of criminal behavior	Based on psychological research	Behavioral Therapy	Strong reinforcement programs can control criminal behavior	Economic incentives and punishments are important.
Wilson and Kelling (1982)	Broken Windows	Protection of communities and crime prevention	USA, community-based	Sociological Approach	Maintaining community integrity is effective in crime prevention	Proactive strategies have been suggested.
Cornish and Clarke (1986)	Environmental Criminology and Crime Analysis	Rational Choice Theory	Micro-level evaluation	Rational Choice Theory	Crime is committed by evaluating available opportunities and constraints	Motivation and opportunity are assessed.
Cerro ve Meloni (2000)	Determinants of the crime rate in Argentina during the '90s	Unemployment and crime relationship	Argentina, 1990-1999	Panel Data Analysis	Unemployment is a strong and positive determinant of crime	Economic and social factors are considered.
Buonanno and Leonida (2006)	Education and Crime	Relationship between education level and crime	Italy, 1980-1995	Panel Data Analysis	The number of crimes committed decreases as education level increases	Education level affects crime rates.
Demir, Çelik, Çetin and Özkan (2011)	Why did crime decrease in New York during the Giuliani era?	Relationship between unemployment and crime rates	USA, New York, 1993-2005	Regression Analysis	There is a positive relationship between unemployment and crime rates	Economic incentives and punishments affect crime rates.

Table 3. Selected National Literature on Economic Variables

Authors and Year	Title	Research Topic	Dataset and Period	Methodology	Key Findings	Comments
Yamak and Topbaş (2005)	Causality Correlation Between Crime and Unemployment	Causality relationship from unemployment to crime	Türkiye, 1995-2002	Causality Analysis	Unemployment has a unidirectional causality relationship towards crime.	Statistically significant.
Pazarlıoğlu and Turgutlu (2007)	Income, Unemployment, and Crime	Relationship between income and crime	Türkiye, 1968-2004	Causality Analysis	There is a positive relationship between income and crime.	Increase in welfare level affects crime rates.
Aksu and Akkuş (2010)	An Essay on Socioeconomic Determinants of Property Crimes in Türkiye	Relationship between income and crime	Türkiye, 1970-2007	Panel Regression Analysis	There is a negative relationship between income and crime.	There is a positive relationship between unemployment and crime rates.

Table 4. Selected National Studies on Social and Behavioral Variables

Authors and Year	Title	Research Topic	Dataset and Period	Methodology	Key Findings	Comments
Cömertler and Kar (2007)	Socio-Economic Determinants of Crime Rates in Turkey	Education level and property crimes	Türkiye, 2002	Cross-Sectional Analysis	Education level does not reduce crime rates	Quality of education system noted as low
Durusoy, Köse and Karadeniz (2008)	Can Major Socio-Economic Issues Be Determinants of Crime? An Interprovincial Analysis in Turkey	Impact of education level on crime types	Türkiye, 2002-2005	Multiple Regression Analysis	Increase in education level reduces crime propensity	Education increases income and reduces crime
Yıldız, Öcal and Yıldırım (2010)	Socio-Economic Determinants of Crime	Education level and crime relationship (Kayseri)	Türkiye, Kayseri, 2002-2008	Panel Regression Analysis	Positive relationship between number of high school graduates	Number of police reduces crime rates

					and crime rates	
Polat, Eren and Erbakıcı (2013)	Evaluation of Factors Affecting Theft Crime and Approaches for the Future	Impact of socio-demographic factors on crime	Türkiye, 2012-2015	Classical Regression Analysis	Increase in per capita income increases theft crime rates	Regional development rate affects crime rates

This study examines the relationship between crime rates and economic factors in G7 countries from 1990 to 2021 using panel data analysis. By evaluating the impact of economic crises and social expenditures on crime rates with a comprehensive and long-term dataset, the research provides an updated perspective and policy recommendations to the literature. Additionally, by analyzing both economic and social variables, the study addresses the dynamics of crime economics with a holistic approach.

2. MODEL AND DATA ANALYSIS

As of 2024, data from 1990-2021 has been utilized to analyze the relationship between crime rates and economic and social indicators in G7 countries. This study examines the effects of selected economic and social factors on crime rates.

Table 5. Model Notations

<u>Variable Names</u>		<u>Definition</u>	<u>Unit of Expression</u>	<u>Source</u>
Dependent Variable	CR	Crime Rate	%	Macro Trend
Independent Variables	INF	Inflation Rate	%	World Bank
	UNEMP	Unemployment Rate	%	ILO
	GDPPC	GDP per Capita	USD	World Bank
	URB	Urbanization	%	World Bank

	SPI	Social Development Index		Index Score	Social Progress Imperative		
	SOCEXP	Social Welfare Expenditures		Million USD	OECD		
	G7 Countries						
	Canada	Germany	France	England	Italy	Japan	USA

The model equation has been formulated as follows:

- $CR = \beta_0 + \beta_1 UNEMP_{i,t} + \beta_2 GDPPC_{i,t} + \beta_3 INF_{i,t} + \beta_4 URBI_{i,t} + \beta_5 SPI_{i,t} + \beta_6 SOCEXP_{i,t} + u_{i,t}$

When examining the variables affecting crime rates, the homogeneity-heterogeneity status of the panel data was analyzed using the Hsiao (2014) homogeneity test. To determine cross-sectional dependence, the Breusch-Pagan LM test (1980), the Pesaran (2004) enhanced test, and the Bias-Adjusted LM test developed by Pesaran et al. (2008) were employed (Koçak & Uçan, 2023). The stationarity of the variables was examined using the Bai and Ng (2004) panel unit root test. For model estimation, the Chow (F) test (1960) was used to test cross-sectional and time effects, the Breusch-Pagan LM test (1980) was used to compare pooled models with random effects, and the Hausman test (1978) was applied to choose between fixed and random effects. These tests were used to enhance model accuracy and determine the appropriate methodology.

2.1. Homogeneity-Heterogeneity Test

The homogeneity test developed by Hsiao (2014) is used to determine whether the coefficients of the independent variables in the model exhibit differences.

The hypotheses of the test are as follows (2014):

- $H_1 = H_0$: Panel is Homogeneous vs. H_1 : Heterogeneous
- $H_2 = H_0$: H_3 vs. H_1 : Panel is Heterogeneous

- $H_3 = H_0$: Panel is Homogeneous vs. H_1 : Panel is Partially Homogeneous

Table 6. Homogeneity-Heterogeneity Test

Hypothesis	F-Statistic	P-Value
H1	300.3105 (0.0000)	459.0017 (0.0000)
H2	43.09854 (0.0000)	67.58513 (0.0000)
H3	42.98564 (0.0000)	67.47222 (0.0000)

Based on Hsiao's (2014) homogeneity-heterogeneity tests, it was determined that the coefficients of the independent variables are heterogeneous across cross-sections. This indicates that the effects of variables differ between countries or time periods, and this variation should be considered in the analysis.

2.2. Cross-Sectional Dependence

Cross-sectional dependence in panel data analysis indicates how changes in one unit affect other units. This type of dependence suggests that units are not independent but are interrelated. Testing for cross-sectional dependence is essential to prevent statistical errors and ensure the consistency of results in the analysis. Ignoring this dependence can lead to biases and inconsistent results, making such tests crucial (Koçak & Uçan, 2023).

Several methods are used to test cross-sectional dependence. The Lagrange Multiplier (LM) test developed by Breusch and Pagan (1980) is based on the average of pairwise correlation coefficients and is suitable for situations where the time dimension is greater than the cross-section dimension ($T > N$). This test is a crucial tool for identifying cross-sectional dependence. The Pesaran Scaled LM test, developed by Pesaran (2004), is a scaled version of the LM test and can be applied in cases where the time dimension is greater than the cross-section dimension. This test measures cross-sectional dependence more

precisely by incorporating mean and variance. The Bias-Adjusted Cross Sectionally Dependence Lagrange Multiplier (LMadj) test, developed by Pesaran et al. (2008), adjusts the LM test with mean and variance, making it particularly suitable for cases where the time dimension is greater than the cross-section dimension. These tests are critical in panel data analysis to prevent biases and inconsistent results.

The hypotheses for these tests are as follows:

- H_0 : There is no cross-sectional dependence.
- H_1 : There is cross-sectional dependence.

Table 7. Cross-Sectional Dependence (CD) Test in Panel Data

Test	CR	GDPPC	URB	UNEM P	SPI	SOCEX P	INF
BP LM	300.310 5 (0.0000)	459.001 7 (0.0000)	243.382 6 (0.0000)	96.6574 7 (0.0000)	650.904 6 (0.0000)	315.6167 (0.0000)	276.941 9 (0.0000)
Pesaran Scaled LM	43.0985 4 (0.0000)	67.5851 3 (0.0000)	34.3143 8 (0.0000)	11.6742 0 (0.0000)	97.1963 9 (0.0000)	45.46034 (0.0000)	39.4926 9 (0.0000)
Bias- correcte d Scaled LM	42.9856 4 (0.0000)	67.4722 2 (0.0000)	34.1977 1 (0.0000)	11.5613 0 (0.0000)	97.0834 9 (0.0000)	45.34743 (0.0000)	39.3797 8 (0.0000)

Cross-sectional dependency tests have been found significant with low p-values ($0.0000 < 0.05$), indicating strong cross-sectional dependence. These results suggest that macroeconomic shocks affect other units, highlighting the necessity of considering cross-sectional dependence for accurate analysis (Peseran M., 2024; Breusch & Pagan,1980).

Due to the presence of cross-sectional dependence and heterogeneity, unit root tests will be applied to determine the stationarity of the variables in the panel dataset. These tests check whether the series are stationary and ensure the accuracy and reliability of the model (Levin, Lin, & Chu, 2002). By using unit root tests, we can prevent

spurious regression issues and reliably examine the long-term relationships of the series.

2.3. Unit Root Analysis

Given the detection of cross-sectional dependence and heterogeneity, it is necessary to apply second-generation unit root tests to determine the stationarity levels of variables in the panel data set (Gül & İnal, 2017). These tests check whether the series are stationary over time and are critical for ensuring the model's accuracy. Thus, spurious regression problems are prevented, and the long-term relationships of the series are reliably analyzed.

Panel unit root tests are categorized into first-generation and second-generation tests based on their approach to evaluating cross-sectional dependence. First-generation tests do not account for cross-sectional dependence, while second-generation tests consider this dependence, leading to more accurate results (Özaydın & Yeşilkaya, 2020). In cases of cross-sectional dependence and heterogeneity, the second-generation unit root test developed by Bai and Ng (2004) can be utilized. This test is preferred due to its ability to account for dependence, its flexibility, and its acceptance of heterogeneity.

The hypotheses of the Bai and Ng test, unlike other tests, are as follows (Topal, 2016):

- H_0 : Stationary
- H_1 : Has a unit root

Table 8. Unit Root Testing

<u>Variables</u>	<u>Constant (p-value)</u>
CR	0,09206
GDPPC	0,98515
URB- d(URB)	0,00002- (0,22471)
UNEMP	0,32369
SPI	0,42379
SOCEXP	0,24533
INF	0,45997

According to the results of the Bai and Ng (2004) unit root test, all variables are stationary at their levels and do not contain a unit root. This indicates that the series have a constant mean and variance, ensuring that regression analyses will produce accurate results.

2.4. Estimation of the Model

In panel data analysis, fixed effects, random effects, and pooled models are commonly used. In fixed effects models, each cross-section has its own intercept. In random effects models, the intercepts are common and influenced by the error term. In pooled models, all units are considered identical. Model selection involves the use of the Chow test, the Breusch-Pagan test, and the Hausman test. The Chow test examines whether the coefficients vary by time or cross-section. The Breusch-Pagan test assesses the presence of random effects. The Hausman test differentiates between fixed and random effects models, determining the most appropriate model and enhancing the accuracy of the analysis (Koçak & Uçan, 2023).

The Chow (F) test (1960) is used in panel data analysis to determine the presence of unit and time effects. It examines the compatibility of the model with the fixed effects model. Hypotheses:

- H_0 : Pooled Effects
- H_1 : Fixed Effects

The Breusch-Pagan LM test (1980) assesses whether the data exhibit differences across units. It tests the appropriateness of the pooled model versus the random effects model. Hypotheses:

- H_0 : Pooled Effects
- H_1 : Random Effects

The Hausman test (1978) is used to decide between fixed or random effects models. This test evaluates the differences between the estimators of the fixed and random effects models. Hypotheses:

- H_0 : Random Effects
- H_1 : Fixed Effects

Table 9. Model Selection in Cross-Sectional and Time Dimensions

Test Name	Cross-Sectional		Time Dimension	
	Test Statistic	P-Value	Test Statistic	P-Value
F Test	264.353655	0.0000	34.086205	0.2774
BP (LM) Test	1184.895	0.0000	3.594303	0.0580
Hausman Test	1586.121930	0.0000	29.527913	0.0000

These test results indicate that fixed-effects models are more appropriate for cross-sectional data, while pooled-effects models are more suitable for time-series data. The F Test and Hausman Test show that fixed effects are significant in the cross-section, whereas the F Test and BP (LM) Test confirm the presence of pooled effects over time. This suggests that the independent variables should be analyzed with fixed effects for the cross-sectional data and pooled effects for the time-series data.

Table 10. Analysis of Regression Coefficients

Variables		Coefficient	Standart Error	T-Statistic	Probability Value
GDPPC d(URB) UNEMP SPI SOCEXP INF C		-2.75E-05	6.37E-06	-4.311751	0.0000
		0.414386	0.173168	2.392963	0.0176
		-0.082844	0.031151	-2.659469	0.0084
		-0.082800	0.024724	-3.349010	0.0010
		0.049409	0.023166	2.132794	0.0341
		0.082988	0.038401	2.161070	0.0319
		9.384380	1.845682	5.084505	0.0000
Weighted Statistics	R-squared Value	0.924427			
	Adjusted R-squared Value	0.919981			
	F-Statistic Value	207.9478			
	P-Value	0.000000			
	Durbin-Watson Statistic Value	0.281033			

The model examines the effects of various independent variables on crime rates. The findings indicate that the model has a high explanatory power overall and that most of the independent variables are statistically significant. The F-statistic and the corresponding p-value confirm the overall validity and predictive power of the model. However,

the Durbin-Watson statistic suggests that there may be an autocorrelation issue within the model. This issue could affect the reliability and validity of the results.

2.5. Heteroscedasticity, Multicollinearity, and Autocorrelation

Econometric tests are applied to enhance the reliability and accuracy of the model. These tests help assess the suitability of the variables within the model, ensure the assumptions of the model are met, and identify potential errors.

2.5.1. Heteroscedasticity

Heteroscedasticity is defined as the variance of the error terms differing across cross-sections and having non-zero covariances. This issue frequently arises in panel data analysis, similar to time series analysis (Koçak & Uçan, 2023).

Table 11. Heteroskedasticity Test Results

Test	F(6,211)	Prob>F
Leven-Brown-Forsythe HC Testi	25,47	0,0000

According to the results of the Levene-Brown-Forsythe HC (1960) test for fixed effects, it is possible to state that there is an issue of heteroskedasticity, as the p-values are less than 0.05.

2.5.2. Multicollinearity

Multicollinearity occurs when there is a high linear correlation among independent variables, which can reduce the predictive power of the model (Özel & Gezer, 2022). To detect this issue, the Variance Inflation Factor (VIF) test has been employed.

Table 12. VIF Test Results

<u>Variables</u>	<u>VIF</u>
CR	1.218
GDPPC	1.056
d(URB)	1.518
UNEMP	1.108
SPI	3.084
SOCEXP	1.270
INF	1.148

The VIF values indicate low multicollinearity among the variables. All values are below 10, suggesting that it is appropriate to retain the variables in the model (Gujarati, 2003).

2.5.3. Autocorrelation

Autocorrelation, which occurs when there is a relationship between error terms, can introduce biases in panel data analysis and reduce the reliability of the model (Yavuz, 2009).

Table 13. Durbin Watson Test Statistic

<u>Positive Autocorrelatio</u>		<u>Indecisive Region</u>		<u>No Autocorrelatio</u>		<u>Indecisive Region</u>		<u>Negative Autocorrelatio</u>		
<u>n</u>	<u>dl</u>	<u>dl</u>	<u>du</u>	<u>du</u>	<u>n</u>	<u>4-du</u>	<u>4-dl</u>	<u>4-dl</u>	<u>n</u>	
0	dl	dl	du	du	4-du	4-du	4-dl	4-dl	4	
0	1.68	1.68	1.84	1.84	2,16	2,16	2,32	2,32	4	
					2					

The Durbin-Watson (1950) test, with 224 observations and $k=1$, yields values of $dl=1.68$ and $du=1.84$. Ideally, the Durbin-Watson statistic should be close to 2. A value between 1.84 and 2.16 indicates no autocorrelation.

Various tests have been applied to identify the presence of econometric issues such as heteroskedasticity, multicollinearity, and autocorrelation. The presence of heteroskedasticity was assessed using the Levene-Brown-Forsythe HC (1960) test, multicollinearity was found

to be low through VIF tests, and the absence of autocorrelation was determined using the Durbin-Watson test. As a result of these analyses, the FGLS test, which is robust to these issues, was used to calculate the coefficients. Consequently, the effects of economic and social factors on crime rates were detailed comprehensively. In light of these findings, it is aimed to develop policies and create more effective strategies in combating crime.

Table 14. FGLS Estimation Results

<u>Variables</u>	<u>Coefficient</u>	<u>Standard Error</u>	<u>z-Statistic</u>	<u>p-Value</u>	<u>Prob>chi²</u>
GDPPC	-8.59e-07	4.26e-06	-0.20	0.840	
d(URB)	1.480372	.9112877	1.62	0.104	
UNEMP	.0813934	.0204835	3.97	0.000	
SPI	-.0565378	.0156292	-3.62	0.000	
SOCEXP	-.0216554	.0096166	-2.25	0.024	
INF	.0271423	.0150671	1.80	0.072	
C	-.0624015	3.667171	-0.02	0.0000	
					0,0000

The model evaluates the effects of various independent variables on crime rates. According to the findings, the variable GDP per capita (GDPPC) is not significant, indicating that its effect on crime rates is not statistically significant. Similarly, the Urbanization (dURB) variable also does not have a significant effect. The Unemployment Rate (UNEMP) variable has a significant effect, with a one-unit increase in unemployment leading to a 0.081 unit increase in crime rates. The Social Progress Index (SPI) has a negative and significant effect; a one-unit increase in social development results in approximately a 0.057 unit decrease in crime rates. The Social Welfare Expenditures (SOCEXP) variable also shows a negative and significant effect, with a one-unit increase in this variable leading to approximately a 0.022 unit decrease in crime rates. At the 10% significance level, a one-unit increase in the Inflation (INF) variable is found to increase crime rates by 0.027 units

3. CONCLUSION and RECOMMENDATIONS

This study examines the key economic and social factors affecting crime rates in G7 countries. The findings indicate that certain economic and social factors have significant effects on crime rates. The increase in unemployment rates has led to a significant rise in crime rates, suggesting that unemployment may drive individuals to commit crimes due to economic hardships. The impact of GDP per capita on crime rates was not found to be significant, indicating that economic prosperity alone is not sufficient to reduce crime rates. The effect of inflation on crime rates is positive and significant at the 10% level, revealing that economic instability increases crime rates. It is understood that urbanization does not have a direct effect on increasing crime rates and should be evaluated together with other socioeconomic factors. An increase in the Social Progress Index has reduced crime rates, demonstrating that social development plays an important role in lowering crime rates. Social welfare expenditures also have a reducing effect on crime rates, indicating that social welfare programs can prevent individuals from turning to crime by alleviating their economic difficulties.

Based on these results, strengthening employment policies, creating new job opportunities, and increasing vocational training programs will be effective in reducing crime rates. Controlling inflation and ensuring economic stability also play a critical role in lowering crime rates. Increasing social development projects and social welfare expenditures can reduce crime rates by improving individuals' well-being. Therefore, policies supporting social development and social welfare programs should be developed.

By analyzing the factors affecting crime rates in G7 countries, this study provides important insights for policymakers and guides the development of effective policies to reduce crime rates.

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CHAPTER 4

A GENERAL DISCUSSION ON THE LOCAL GOVERNMENTS DIMENSION OF PUBLIC ENTREPRENEURSHIP

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INTRODUCTION

Public administration emerged for the operation of the state mechanism and became a model for subsequent administrations. However, public administration has experienced serious crises over time. In order to get out of these crises, it tried to adopt the methods of the private administrations that came after it. In fact, it has made good use of the flexibility and result-orientation gained over time by the private administration, which has been modeled after itself, and has gone far ahead of the public administration. In this context, public administration has sought ways to act with the logic of a private administration, in other words, a company. This has led to the emergence of new public administration or new public management. The understanding based on the management of the state by acting like a company has certain dilemmas in itself. Because the state cannot be pure interest and profit oriented.

The state mechanism is not only organized at the center. It also establishes organizations at different levels. Through regional administrations and, most typically, local governments, the state makes its presence felt to the people. The unique characteristics of local governments make them advantageous at certain points and disadvantageous at others compared to the central government.

Public entrepreneurship is a concept that has come to the fore in the context of this new understanding of public administration. In this study, the concept of public entrepreneurship and the dimension of local governments are discussed. The advantages and disadvantages of local governments in the execution of public entrepreneurship are discussed on the differences between local and central governments. A general evaluation has been tried to be made by linking the concept of public entrepreneurship and entrepreneurial local government.

1. AN ANALYSIS ON THE CONCEPT OF ENTREPRENEURSHIP

The most important production factors affecting economic development and national welfare are natural resources, capital, labor and entrepreneurship. In today's world, among these factors, qualified labor force and entrepreneurship are rapidly coming to the forefront. The issue of entrepreneurship has gained greater importance in the transition to a post-industrial society (Belli et al., 2019). While the economic value of human physical labor is rapidly decreasing, the economic value of intellectual labor is increasing at a greater rate (Atmaca and Karaçay, 2020). Entrepreneurship constitutes the most important dimension of intellectual labor along with management and research and development activities.

Entrepreneurship, as a concept, has been one of the subjects examined by many theorists due to its positive contributions to economic and social life in every period of human history. The emergence of the concept of entrepreneurship in the modern sense is based on the word entrepreneur, which is a French word and originates from the word enterprise. There are two different perspectives on the definition of entrepreneurship in the literature. The first of these is referred to as the economic school. This school defines entrepreneurship as creating value by establishing organizations. Here, entrepreneurs create value by discovering, innovating, using their creativity skills or finding any other new products, services, resources, technologies or markets. The so-called educational school, on the other hand, understands the concept of entrepreneurship primarily in terms of individuals and their behavioral processes. Accordingly, entrepreneurial behavior is defined as creating, developing and transforming organizations through utilitarian, value-oriented, value-adding, risk-taking and creative activities (Aytaç and İlhan, 2007).

There are different definitions of entrepreneurship in the literature and the concept of entrepreneur often means different things to different

authors or organizations. The differences in definitions have led to the fact that the scope and boundaries of entrepreneurial activity cannot be clearly drawn. Despite this, it is possible to classify thinkers who emphasize different aspects of entrepreneurship with their views on entrepreneurship (Aydın and Belli, 2023). Entrepreneurship is important in all developed countries, especially in the USA, and in almost every industry. It is possible to emphasize the importance of entrepreneurship especially for three fields (Coulter, 2001):

- Innovation
- inventiveness, -
- The birth and growth of new businesses,
- Creating new business areas.

The elements that are effective in entrepreneurship have changed in parallel with the characteristics of the period. Along with this change, the answers given to the question of who an entrepreneur is and what characteristics he/she should have differentiated (Arıkan, 2002). In his first studies (1961), David McClelland examined many different characteristics such as sphere of control, tendency to take risks, personal values, tolerance for uncertainty, and found that people with an entrepreneurial spirit have a high desire for success and that these people do not want to retire and do not like routine work based on repetition. The trait-oriented line of research was deemed insufficient to explain entrepreneurship and behavior was considered the best starting point to define entrepreneurship. Therefore, the behavior or reflex to start a business is seen as a behavior that explains entrepreneurship. Entrepreneurship is an event that is characterized by personal differences, but the events experienced can also cause a person to be more active and entrepreneurial or not (Eren, 2000). There are many different entrepreneurial qualities that affect the success of businesses. Entrepreneurship is a combination of some characteristics. An entrepreneur may attach importance to some of these characteristics and may not attach much importance to others (Ceylan and Demircan, 2001).

The most prominent characteristic of people with an entrepreneurial spirit is their high desire for success. Such people do not like routine work and prefer to create new ideas. They are compatible with long-term working hours and do not like retirement; they have a desire to work and produce something. Since many entrepreneurs generally dislike delegation of authority, they are unable to allocate sufficient time for strategically important tasks in their busy schedules. All research shows that the most important characteristic of the entrepreneur is risk-taking. This is a characteristic that distinguishes the entrepreneur from the professional manager. In professional management, profit and risk belong to someone else, whereas the entrepreneur seeks profit and bears the risks that may arise as a result of his/her ventures. In addition to these characteristics, other qualities that play a role in the entrepreneur's success are "being aggressive, creativity, foresight, ability to analyze, ability to make quick decisions, self-confidence, reassurance and rationality" (Çelik and Akgemci, 1998).

If we define what entrepreneurship is in the classical sense, we can say to establish a business in order to gain financial gain, but today, the concept of entrepreneurship is branching out and emerging under various types. Types of entrepreneurships can be listed as follows (girisimsavascisi,2024);

- Internal Entrepreneurship,
- Commercial Entrepreneurship,
- Women Entrepreneurship,
- Social Entrepreneurship,
- Public Entrepreneurship,
- Virtual Entrepreneurship,
- Public Entrepreneurship.

2. BASIC DYNAMICS OF PUBLIC ENTREPRENEURSHIP

There are two main aspects of entrepreneurship. These are private sector (or private entrepreneurship) entrepreneurship and public

entrepreneurship. Private sector entrepreneurship is the economic activities of natural or legal persons based on the basic motivation of making profit. Private sector entrepreneurship is also called "commercial entrepreneurship". Public entrepreneurship, on the other hand, is quite different from private entrepreneurship. First of all, while private enterprises are mostly profit motivated, public enterprises are motivated by the public good. However, this characteristic of public enterprises does not mean that they are free from the profit motive. In today's atmosphere, there are public enterprises in the commercial and industrial sphere that are as profit oriented as private enterprises. However, profit motivation and public interest motivation are not the only criteria that distinguish between public and private enterprises. In order to clarify the issue, it is important to first define public enterprise. It can be said that there is a large literature on public enterprises. However, almost none of these have a common definition of the concept of "public enterprise". The situation experienced by a classical social science concept also emerges here. The lack of a single definition points to the breadth of the concept and the fact that it can be handled in different dimensions from different perspectives (Aktan, 2010).

The most characteristic feature of public entrepreneurship is that the entrepreneur and the provider of capital is not an individual or a private company, but a public institution. In this case, the product or service is produced by the state itself. The main feature that distinguishes public entrepreneurs from other entrepreneurs is that they are not free or only partially free in their business. This is because the state does not enter any sector to make more profit. It also does not pursue a destructive strategy by setting aggressive sales or marketing strategies. It acts in a balancing and public interest-oriented manner in both production and sales.

One of the best examples of public entrepreneurship in Turkey is the products produced by Atatürk Forest Farm. This enterprise sells products such as yogurt, honey, ice cream, cheese, milk, etc. and the

profits from these products belong to the state. In addition, the "Tekno Catalog" initiative run by the State Supply Office (Devlet Malzeme Ofisi-DMO) is also an example of public entrepreneurship.

Public entrepreneurship activities carried out by institutions and organizations in the public sector support the creation of new service areas and are mostly carried out with the investment partnership of public banks.

In addition, the table below shows the differences between public entrepreneurship and private sector entrepreneurship.

Table 1: Comparison of Public and Private Sector Entrepreneurship (Kearney et al., 2007).

Criteria	Public Entrepreneurship	Private Sector Entrepreneurship
Targets	Objectives are more numerous and more varied.	Goals and objectives are more clearly defined; there is more consistency between objectives
Decision Making	Less decision-making autonomy and flexibility, more restrictions on procedures and operations; subject to public scrutiny, major decisions must be transparent	More flexibility and autonomy in decision-making; more participatory and independent in decision-making
Authority	More authoritarian; more centralized or centrally controlled.	More democratic; more decentralized
Risk/reward	Risk and reward trade-offs lead to avoid mistakes; lower financial incentives; ventures do not share profits	Identifies risk factors and aims to minimize them; assumes calculated risk, invests personal capital in the business; receives higher financial incentives; profitability is

		essential to generate income
Motivation	There is lower commitment and job satisfaction.	Higher levels of commitment and job satisfaction.
Financing and Profit	Not constrained to a narrow profit; easier to secure financing for risky projects; easier to raise capital; not for profit, but instead driven by political and social objectives	May be constrained by a narrow profit margin; risky projects are more difficult to access and fund; raising capital is difficult; profit oriented.
Restrictions	The constraints on growth and authority faced by the private sector do not apply to the public sector.	There may be constraints on the growth and authority of the venture.
Independence	It gains independence by overcoming dependencies.	Achieves independence by avoiding or minimizing dependencies.

3. A GENERAL THEORETICAL ANALYSIS ON LOCAL GOVERNMENTS

Modern states in today's world are organized at different levels. At this point, the most prominent organizations are central government and local governments. This is based on different methods of providing public services. In some countries, the services provided by the central government are provided by local governments in others. The main issue that arises at this point is the allocation of public duties and services between central and local governments. The difference in perspectives on this issue can be attributed to the differences in the definitions of these concepts (Bulut and Taniyici, 2008). When it comes to service delivery, there is a differentiation between the state's traditional understanding of

public services and local government services (Yılmaz and Mecek, 2019). It is not possible to make a clear distinction or develop a basic principle on which services should be the responsibility of central government institutions and which should be the responsibility of local governments. However, the only clear distinction can be made with the perspective that the central government should provide services that span the whole country and local governments should provide locally specific services (Sezer and Vural, 2010). At this point, the question can be asked as to which services belong only to the locality and do not affect the center.

A strong centralization of the state may not be sufficient to reflect the effectiveness of public policies and services. In terms of functionality, this management style is not effective due to the diversity and different requirements of local services. Local services provided by local governments will increase efficiency with the principle of fitness for purpose and facilitate reaching a more accurate, fast and participatory solution (Seçkiner Bingöl, 2021). From a different perspective, greater empowerment of local governments by the central government will also reduce the amount of work that the central government has to do, which will allow the central government to focus on more important issues and national policies (Yılmaz and Telsaç, 2021).

There is no doubt that decentralization has both tried and true advantages. The first is that it allows people to take part in the management of affairs that directly affect them. Local governments are also important in determining the local decisions that affect them. This strengthens the people's sense of responsibility and their ability to reconcile with the state as a whole. In this sense, local governments are a school of democracy for both the voter and the elected. Active participation in social and local political activities fosters solidarity and cooperation for the greater good, while increasing personal effectiveness and self-confidence. This effective cooperation and partnership create a

healthy mechanism for controlling overall policies. It also serves as a driving force behind regional development (Yılmaz and Çelik, 2019).

Decentralization not only facilitates the delivery of services, but also ensures that local needs are properly assessed, and resources are appropriately allocated on the ground (Bülbül, 2006). The best example of decentralization is local governments. Defining local governments is not a simple task and the difficulty stems from the large number of typologies available in scholarly debates. Researchers should adjust and update existing typologies to cover all countries. Local government systems are also related to the interpretation of democracy, problem definition, attitudes towards decentralization or centralization, and public sector reforms (Heinelt and Hlepas, 2006). In essence, local government refers to a form of public administration operating at the regional or local level, whose primary purpose is to provide governance and services to a specific geographical area. The main characteristics of local government include autonomy to take independent actions, the presence of elected officials, and the ability to collect revenue through taxes or other means. In addition, local governments have the authority to make decisions on land use, public safety, transportation and similar services. However, it should be noted that the scope and powers of local government vary across countries and regions (Altıntaş, 2020). Local government refers to a public legal entity established to meet the common needs of local communities in a certain geographical area, whose decision-making body is elected by the local population, whose duties and powers are determined by law, and which has a special revenue and budget.

Local governments have their own organization and staff separate from the central government. With these qualities, local governments constitute one of the basic elements of democratic governance structures that are integrated in almost every society as well as sociological factors in order to increase efficiency in the provision of local public services (Urhan, 2008). Local governments are legal entities recognized by the

public. These organizations have specific revenue, budget and personnel resources. Their decision-making bodies are established by local residents to meet the social needs of those living in a defined geographical area. These organizations have duties and powers defined by law. They can be defined as a democratic and autonomous level of governance that operates outside the central government. They are established to fulfill the needs of local people, which are also local in nature, and their decision-making bodies are directly elected by the people. They have their own legal identity and existence, as well as unique sources of revenue that are separate from the normal identity of the state. These organizations have developed in parallel with societies to achieve specific goals and respond to specific needs (Tortop, et al., 2008).

Article 127 of the Constitution of the Republic of Turkey defines local government as follows: "Local administrations are public legal entities whose principles of organization are specified by law and whose decision-making bodies are elected by the electorate in order to meet the local common needs of the people of a province, municipality or village. The establishment, duties and powers of local administrations shall be regulated by law in accordance with the principle of decentralization. Elections of local administrations shall be held every five years in accordance with the principles laid down in Article 67. (Repealed second sentence: 21/1/2017-6771/16 Art.) The law may introduce special forms of administration for large settlement centers. The resolution of the objections of the elected organs of local administrations regarding their acquisition and loss of the title of organ shall be subject to judicial review. However, the Minister of Interior may, as a provisional measure, suspend the local administration bodies or members of such bodies against whom an investigation or prosecution is initiated for an offense related to their duties, until final judgment. The central administration shall have administrative tutelage power over local administrations in accordance with the principles and procedures set forth in the law for the

purpose of carrying out local services in accordance with the principle of unity of administration, ensuring unity in public duties, protecting the public interest and meeting local needs as required. The establishment of unions among local administrations with the permission of the President of the Republic for the purpose of providing certain public services, their duties, powers, financial and law enforcement affairs and their mutual ties and relations with the central administration shall be regulated by law. These administrations shall be provided with sources of revenue commensurate with their duties." As can be seen, Article 127 of the Constitution states that there are three types of local governments. These are special provincial administration, municipality and village. The 1982 Constitution, unlike other constitutions, envisages the establishment of large settlement centers. Thus, metropolitan municipalities were established in metropolitan areas with dense populations. Another noteworthy point in the Constitution is administrative tutelage. Administrative tutelage was introduced to ensure unity in public services within the scope of the principle of the integrity of the administration. Thus, the central government exercises administrative tutelage power against the actions and transactions of local governments.

4. ENTREPRENEURIAL LOCAL GOVERNMENTS AS A DIMENSION OF PUBLIC ENTREPRENEURSHIP

Local governments are one of the most important components of local and even central development. Being the closest state institution to the public and being able to act more flexibly compared to the center, it ensures that the targeted goals are more attainable through the entrepreneurial methods it uses. The wide service area of local governments raises expectations from them. For this reason, municipalities have more opportunities to serve and innovate. Determining a local image and accelerating the economic and social development of the city is a function undertaken by local governments and providing mutual gain (Atmaca and Geylani, 2020). A change

occurring locally will make the service area attractive, which will prevent the local population who want to migrate in order to improve their quality of life. At the same time, a successful entrepreneur increases the added value by taking in immigration from outside where there is a local government. Effective local government entrepreneurship works to meet an existing need or demand. In these studies, he makes use of his own research as well as previously applied and learned methods of drawing negative or positive lessons. Creativity to come up with new ideas; Putting these ideas into practice and implementing them is innovation in management. Therefore, in a local government structure, entrepreneurship and innovation are two important concepts that must act together and are integrated with each other. Entrepreneurship roles are important for producing, developing and implementing new applications in public administration (Ceritli and İzci, 2016). In addition, considering the function of mobilizing resources, which is one of the functions of the state, it is important that not only the entrepreneur is the local government, but also the entrepreneur is friendly (Maruf et al., 2023).

5. EVALUATION OF THE ENTREPRENEURSHIP DIMENSION OF LOCAL GOVERNMENTS

Although development in a country has different dimensions, it starts from the local level in the healthiest way. Development that takes place locally moves to the region and then to the national level. In this way, states that have been able to achieve development that works locally and towards the center are at the top of international development levels. What comes to the fore while doing this is the existence of entrepreneurial local governments, which form the main axis of the study. The most important issue that caused this situation to emerge is the new public management, or in other words, new public management, which emerged as a solution to the administrative problems that the modern state faced. In particular, the new public management approach,

which became more evident after the 1980s, and as an extension of it, the adoption and implementation of the entrepreneurial management approach have brought a different dimension to public administration. This understanding involves the participation of all stakeholders in management at the local level, effective leadership, and acting within the framework of strategic plans and policies by evaluating opportunities and threats together. It would not be wrong to say that local governments are the most important units where the entrepreneurial management approach is implemented (Öztürk, 2020). Because, unlike other public entrepreneurship, it is possible to open businesses that do not have very large budgets and big goals. This will facilitate both profit and public benefit. An entrepreneurial local government has features such as establishing cooperation between all relevant actors in the local area, measuring the capacity of local entrepreneurs and improving their skills, handling local plans in a way that will encourage local development, improving the quality of the workforce and leading the way in taking into account the local economic reality.

Local administrators elected by local people to meet their local needs cannot remain indifferent to local problems and local demands. While doing this, it will be difficult in certain cases to provide services with a classical administrative structure limited by law. The main reason for this is the abundance of tasks given to local governments, not only in Turkey but almost everywhere where local governments are elected by democratic methods. Using entrepreneurial methods should also be considered as a way out to meet this excessive workload. In this way, it is possible to achieve sustainable development by using limited opportunities and resources efficiently.

For example, the local government generates income for itself by producing or trading the product that the public already buys or tends to pay a certain amount of money for. In doing so, it aims not only to make a profit but also to have certain other effects. These goals can be listed as follows:

- Ensuring supply security,
- Preventing price increases,
- To present the product with high quality,
- To prevent price fluctuations of the product,
- Breaking the monopoly or oligopoly that has formed,
- Ensuring that the product reaches different segments of society,
- To support other suppliers or manufacturers by creating a sample production model.

CONCLUSION

The new public management approach that public administration has produced in order to get out of the crisis it is in, focuses on whether the state can also act with the logic of a company at this point (Atmaca and Geylani, 2020).

It is quite normal that local governments, which are the closest units to the people, are the institutions that give the most importance to local needs. The most prominent reason for this is that the administrators, who derive their legitimacy from the local people as a requirement of democracy, cannot remain indifferent to local demands. Finding solutions to local expectations and demands with entrepreneurial spirit as well as with routine methods by local governments is one of the most important discussions of the new era.

The demands of the public are also effective in this. The public no longer wants to see local governments as organizations that only collect garbage, provide water, perform cleaning and law enforcement duties.

When looked at in Turkey specifically, the duties of the municipality in the Municipality Law No. 5393 are: "Urban infrastructure such as zoning, water and sewage, transportation; geographical and urban information systems; environment and environmental health, sanitation and solid waste; police, fire department, emergency aid, rescue and ambulance; urban traffic; burials and cemeteries; afforestation, parks and green areas; housing; culture and

arts, tourism and promotion, youth and sports; social services and assistance, marriage, vocational and skill training; "Provides or procures services for the development of economy and trade." It is stated as. Especially the part related to economy and trade can be considered as the starting point of entrepreneurial local governments. Encouraging investments in a certain region or city instead of placing the burden on public investments or municipal enterprises; Policies such as "intermediation" between the active forces in the region, finding partners and following policies to ensure cooperation in a way that creates synergy (Göymen, 2010) have become widespread and have become the method frequently used by local governments of a certain size. In this context, It is important to build a system in which local governments are not only dominated but also local collaborations are encouraged. Directing different social levels of local governments like companies enables activities that are not only profit- and production-centered but also have a social content. In this way, it is possible to reach a wide segment of society, especially disadvantaged groups.

Very rapid developments in technology have a dimension that touches not only a certain subject but also the whole society and society-related issues. Nowadays, the technologies used by the individual are increasing, and in parallel, the expectations of accessing or managing these technologies are also changing (Aydın and Temel, 2020). In this context, the titles in the pool of local government duties mentioned today will be renewed in the future as the dynamics of the society change. In this context, finding new solutions to new problems centering on entrepreneurship will be one of the most important issues that will make the job of local governments easier.

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CHAPTER 5

THE EFFECTS OF PERFORMANCE-BASED LOGISTICS ON GROWTH, QUALITY AND EFFICIENCY: A STUDY IN TURKISH AUTOMOTIVE INDUSTRY¹

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INTRODUCTION

Logistics has been the subject of research due to the changes in the globalizing and developing world. Logistics, which people define as transporting a product from one point to another, is briefly expressed as transportation. However, the logistics process has a much more complex structure that includes all stages of a product throughout its life cycle. These stages include the conceptual design of the product, the R&D phase, the production of the first sample (prototype) by determining the production methods, the release of the product to the market, the creation of transportation to take place on the shelves, the creation of networks for customer satisfaction and customer relationship management of the product, providing service support, collecting spare parts in sufficient quantities and reusing them as soon as possible without victimizing the customer, and after all these processes, it is a process that results in recycling or disposal after the product has completed its life.

Today, logistics is an essential element that will enable enterprises to compete in the market by providing superiority over their competitors in performance analysis, production, stock, and similar areas. In recent years, it is seen that enterprises that have succeeded in adapting the performance-based logistics process to their enterprises have benefited economically by preventing serious waste and using their resources more efficiently and effectively.

Logistics performance is based on a set of performance indicators used to measure the effectiveness and efficiency of logistics activities. These indicators include factors such as the speed and accuracy of logistics processes, delivery times, inventory levels, storage capacity utilization, and customer satisfaction. These performance indicators help enterprises monitor, analyze, and improve their logistics operations.

Performance-based logistics is an approach that uses performance measures to optimize enterprises' logistics processes and activities. This approach makes an enterprise's logistics operations more effective and efficient, reduces costs, improves customer service, and gains

competitive advantage. Performance-based logistics helps enterprises gain a competitive advantage by enabling them to continuously monitor and improve their logistics operations.

Although PBL studies have increased in recent years, these studies have generally been conducted in the public sector and defense industry. This study focuses on the applicability and reflections of PBL practices in the private sector. The idea that testing the research variables in a population that has not been selected as a sample before will contribute to the related field constitutes the starting point of this study.

To make logistics support faster and more efficient in competitive markets, it is necessary to introduce performance-based logistics processes that have started to be included in the literature, to determine performance scales and to measure these determined qualities. In this study, the theoretical framework obtained as a result of the literature review is tested and a structural equation application in the Turkish automotive supply industry is presented. Thus, the predisposition of the sector was evaluated by conducting research on the appearance of PBL applications, which are primarily handled in the defense industry and created with information produced in the USA in the Turkish automotive sector.

1. TURKISH AUTOMOTIVE SECTOR

The automotive industry plays an important role in following up and transferring technological developments in the Turkish manufacturing industry. With the added value it provides to the Turkish economy, the automotive sector is in a leading position. To provide more added value and increase competition, it is necessary to transform the production-centered perspective into a center of excellence. Thanks to this transformation, both sustainability and customer satisfaction will increase (Yayar and Yılmaz, 2016: 72).

Since the foundation of the Turkish automotive sector, which was established to protect the economy against imports, significant progress

has been achieved. This development process is discussed in four main groups as shown in Figure 1 (Ministry of Industry, 2016: 5)

Figure 1. Development Process of the Turkish Automotive Industry.



Source: Ministry of Industry, 2016.

The automotive sector, where a vehicle is manufactured every 13 seconds and a vehicle manufactured every 18 seconds is exported, is a locomotive in industrial production and the national economy. The automotive industry is a locomotive sector with its production rate, innovations and technological uses, as well as its contributions to the literature with its studies. When the leading countries in the automotive manufacturing sector are examined, it is seen that innovation is given importance and the share allocated to R&D expenditures to ensure continuity is higher than other sectors. In addition to its support to the industry and its contribution to employment, 121 R&D centers across the country contribute to innovations in the sector and technology, and the same characteristics apply to Turkey (TSKB, 2017: 13; OSD, 2023).

In terms of employment, the automotive sector accounts for approximately 5% of Turkey's total employment, and the share of direct and direct employment in industrial employment is 11%. In addition to employment, automotive industry production accounts for 3% of GDP. In industrial production, automotive production accounts for 9% of total industrial production (OSD, 2023).

When Turkey's export figures are evaluated, the automotive industry is seen as extremely important for the Turkish economy. According to data from the Turkish Exporters Assembly (TİM), the automotive sector is ahead of other sectors by a large margin when the last twelve years of the Turkish economy's exports are analyzed on a sectoral basis (TİM, 2019).

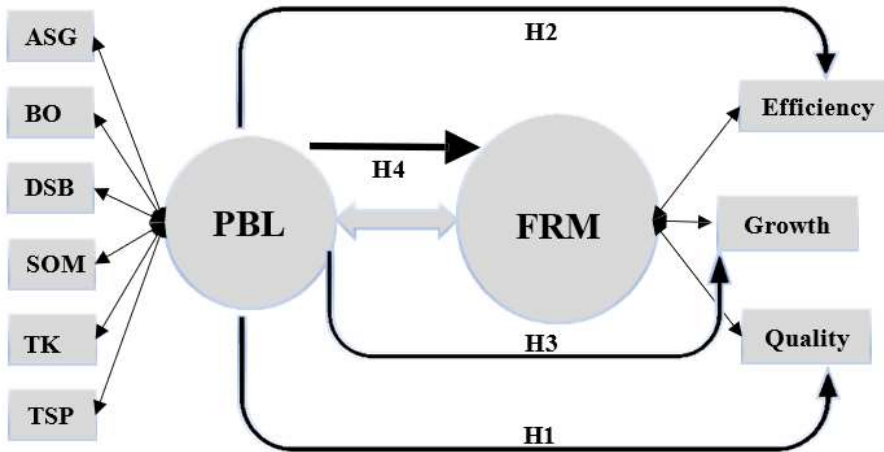
According to TİM (Turkish Exporters Assembly) data, total automotive industry exports ranked 14 percent in sectoral exports in the first quarter of 2023. In the first quarter, total automotive exports increased by 17 percent compared to the same period in 2022, reaching 8.8 billion dollars (TİM, 2023). In 2021, Turkey's total exports increased by 33 percent. Exports of the automotive sector increased by 15 percent and thus continued to maintain its first place with a 13 percent share in total exports in its 16th year (OSD, 2022). As of the end of 2019, imports of "Motor vehicles, tractors, bicycles, motorcycles, and other land vehicles" increased by 2.6% compared to the same month of the previous year and amounted to 1 billion 174 million USD, and exports increased by 5.1%. They amounted to 2 billion 274 million USD, and a foreign trade surplus of approximately 1 billion 99 million USD was reported (ODD, 2020: 10).

2. PURPOSE OF THE STUDY

The research investigated the effects of performance-based logistics, which the US Department of Defense uses in the maintenance and operation of defense industry projects, on the logistics chain and the growth, quality, and efficiency of enterprises in the Turkish vehicle sub-industry.

Within the framework of the above-mentioned objectives, the hypothesis developed by making use of the literature and analyzed using structural equation modeling are presented below for the development of enterprises when they apply performance-based logistics;

Figure 2. Effect of Performance Based Logistics on Enterprises and Hypothesis.



H1: Performance Based Logistics (PBL) practices have a statistically significant and positive effect on the quality of enterprises (FRM).

H2: Performance Based Logistics (PBL) practices have a statistically significant and positive effect on the efficiency (FRM) of enterprises.

H3: Performance Based Logistics (PBL) practices have a statistically significant and positive effect on the growth of enterprises (FRM).

H4: Performance Based Logistics (PBL) practices have a statistically significant and positive effect on the quality, growth and efficiency (FRM) of enterprises.

3. ANALYSIS AND FINDINGS

Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM) were applied to analyze the data. In the study conducted for the automotive industry, computer programs were utilized and the validity and reliability of the multi-item scales were examined.

First, an Exploratory Factor Analysis (EFA) was conducted with the SPSS program. Then, Confirmatory Factor Analysis (CFA) was conducted to verify the explained scales. LISREL program was used to investigate the fit indices in CFA. By taking the mean values of the variables through the LISREL program, the conformity of the data to the normal distribution was tested. Again, The Structural Equation Model (SEM) was conducted with the LISREL program, and the hypothesis of the research was examined.

3.1. Preparation of the Questionnaire Form

As a result of all the evaluations made, it was decided that 51 questions formed from 91 scales used by the US Department of Defense (PBL Guidebook, 2016: 165) and intended for military purposes could be used in the survey form as PBL questions for the automotive supply industry in the private sector, due to reasons such as having the same meaning and causing misunderstanding. In addition, it was decided to include 18 questions to measure the growth, efficiency, and quality of enterprises in the questionnaire form.

3.2. Explanatory Factor Analysis

The purpose of conducting an Exploratory Factor Analysis (EFA) is to identify the basic structure in a data group and to determine the dimensions that make up this structure (Ha & Stoel, 2009:569). EFA is generally the preferred method for assessing the underlying structures of data (Helfrich et al., 2007: 5). Exploratory factor analysis was conducted using SPSS software to determine the resulting factor loadings and whether the data support alternative factor loadings. During EFA, factor loadings were calculated and factor loadings were expected to meet the criterion of > 0.5 with the condition that eigenvalues > 1 while determining the dimensions (Bülbül et al., 2012: 34).

The suitability of the data obtained from the study group for explanatory factor analysis can be explained by Kaiser-Meyer-Olkin (KMO) and Barlett test. A high KMO value means that other variables

can perfectly predict each variable in the scale. If the values are zero or close to zero, no interpretation can be made based on these values because there is a scatter in the correlation distribution. As a result of the KMO test, if the value is lower than 0.50, it is interpreted that factor analysis cannot be continued (Kalaycı, 2010).

3.2.1. Explanatory Factor Analysis of Quality, Growth, and Efficiency Variables of Enterprises (FRM)

The findings of the EFA for the growth, efficiency, and quality questions (FRM) of the enterprises Cronbach's Alpha value, which is the reliability coefficient for the overall items related to the quality, growth, efficiency questions (FRM) of the enterprises in the EFA, was obtained as 0.934. The Cronbach's Alpha (α) value obtained for the questions in the questionnaire shows the total reliability of the questionnaire, and according to Kalaycı (2010), these values obtained in the calculations show that the scale used in the research is a "highly reliable" scale.

In the Explanatory Factor Analysis (EFA) calculations, the growth, efficiency, and quality factors explain 68.705% of the total variance.

3.2.2. Explanatory Factor Analysis of Performance-Based Logistics Questions (PBL) of Enterprise

EFA findings regarding the performance-based logistics questions (PBL) of the enterprises The Cronbach's Alpha value, which is the reliability coefficient for the items related to performance-based logistics (PBL) practices of the enterprises in the EFA for the questions of Cost of Ownership (SOM), Main System Reliability (ASG), Supply System Performance (TSP), Supply Demand Fulfillment (TK), Maintenance and Repair (BOM) and Depot Level Maintenance (DSB) while applying PBL, was obtained as 0.934. These values obtained in the calculations show that the scale used in the research is a "highly reliable" scale.

The total variance explanation rate for these 6 factors is 63.225%.

3.3. Confirmatory Factor Analysis

Confirmatory factor analysis is applied to determine which of the factors used are more appropriate for the data (Calantone, 2002: 519). Using the results of the exploratory factor analysis, confirmatory factor analysis was conducted on the data to obtain and compare appropriate indices. CFA is conducted with LISREL using maximum likelihood estimation of the variance-covariance matrix (Alberts et al., 2011: 613).

Confirmatory factor analysis enables the identification of factors or factors depending on the relationships between variables. Confirmatory factor analysis investigates whether the model developed with confirmatory factor analysis is confirmed or not, or to what extent the expected model and the observed model fit. Confirmatory factor analysis is a powerful technique. Because it allows control over the items and factors while testing the model assumed by the researcher. While evaluating the results of confirmatory factor analysis, more than one fit index is utilized (Bülbül, 2012: 163).

To assess whether the model is statistically significant, model fit was evaluated with multiple fit indices. Bentler-Bonnett non-normal fit index (NNFI) and comparative fit index (CFI) are designed to reflect the goodness of fit of a model independent of sample size (Calantone, 2002: 519). Model fit was assessed using root mean square error of approximation (RMSEA), goodness of fit index (GFI) and comparative fit index (CFI). An appropriate model is suggested by GFI and CFI values above 0.90 (liberal criteria) or 0.95 (more stringent criteria) and RMSEA values <0.08 (liberal criteria) or 0.05 (more stringent criteria) (Alberts et al., 2011: 613).

RMSEA, NNFI, GFI and CFI indices were examined for model fit and it was evaluated whether they were at acceptable levels. The fit of the values obtained in the study in terms of the index criteria specified in Table 1. shows that the models established are statistically significant.

Table 1. Values Related to the Fit Criteria of the CFA Model Established for the Variables.

Variables	Fit Criteria						
	RMSEA	NFI	NNFI	CFI	SRMR	GFI	AGFI
SOM	0,075	0,98	0,98	0,99	0,031	0,96	0,92
ASG	0,075	0,98	0,98	0,99	0,031	0,96	0,93
TSP	0,049	0,99	0,99	1	0,018	0,99	0,96
TK	0,048	0,98	0,99	0,99	0,028	0,98	0,96
BO	0,078	0,078	0,078	0,078	0,078	0,078	0,078
DSB	0,00	1	1	1	0,00	1	1
PBL	0,085	0,085	0,085	0,085	0,085	0,085	0,085
VRM	0,047	0,047	0,047	0,047	0,047	0,047	0,047
KLT	0,00	1	1	1	0,00	1	1
BYM	0,083	0,083	0,083	0,083	0,083	0,083	0,083
FRM	0,00	1	1	1	0,00	1	0,83

The fit criteria for the CFA models are presented in Table 2.

Table 2. Fit Criteria for CFA Model.

Fit Measure	Good Fit	Acceptable Fit
RMSEA	$0 < RMSEA < 0.05$	$0.05 \leq RMSEA \leq 0.10$
NFI	$0.95 \leq NFI \leq 1$	$0.90 < NFI \leq 0.95$
NNFI	$0.97 \leq NNFI \leq 1$	$0.95 \leq NNFI \leq 0.97$
CFI	$0.97 \leq CFI \leq 1$	$0.95 \leq CFI \leq 0.97$
SRMR	$0 \leq SRMR < 0.05$	$0.05 \leq SRMR \leq 0.10$
GFI	$0.95 \leq GFI \leq 1$	$0.90 \leq GFI \leq 0.95$

Source: Schermelleh-Engel et al., 2003

3.4. Structural Equation Modeling

Researchers conduct various studies on variables that cannot be directly observed such as achievement, intelligence or beliefs. In order to collect information about these variables, called latent variables,

observable variables are utilized. In other words, each unobservable (latent or hidden) variable is measured with the help of observable variables (Schreiber et al., 2006: 323; Bayram, 2010: 3). Structural equation modeling and factor analyses are statistical techniques that enable calculations to be made regarding unobservable variables by examining correlations/covariances between observable variables (Schreiber et al., 2006: 323). SEM, which offers great potential in theory development and construct validity studies in social sciences, has been successfully used in many studies (Kaya, 2018: 108).

Structural Equation Modeling (SEM) is a form of causal modeling that fits networks of data structures and includes various mathematical models. SEM is considered a powerful model because it uses a combination of explanatory and confirmatory factor analyses. Structural equation models are often used to measure unobservable 'hidden' constructs. It refers to a measurement model in which latent variables are identified using one or more observed variables and a structural model that affects the relationships between the latent variables. Structural equation modeling is used to test both observable and unobservable variables (Çiğdem, 2019: 119).

According to Anderson and Gerbing (1988), the relationships between variables (observable/unobservable) in multivariate models are determined by statistical methods and SEM is carried out in two steps. First, the model is tested with EFA and CFA in order to evaluate the connections between the variables. As in CFA, the data are examined and the fit criteria are checked, and then the hypothesis is tested (Kaya, 2018: 108).

For H1; ASG variable is the most effective variable with a coefficient load of 0.80 on PBL. It can be said that the effect of a one-unit increase in Performance Based Logistics (PBL) on the Quality of enterprises (FRM) will be seen as an increase of 0.57 units.

For H2; SOM variable is the most effective variable with a coefficient load of 0.78 on PBL. It can be said that a one-unit increase in

performance-based logistics (PBL) will provide an improvement of 0.29 units on the Efficiency of enterprises (FRM).

For H3; SOM variable is the most effective variable with a coefficient load of 0.78 on PBL. It can be said that a one-unit increase in performance-based logistics (PBL) provides an improvement of 0.54 units on the Growth of enterprises (FRM).

For H4; SOM variable is the most effective variable with a coefficient load of 0.77 on PBL. It can be said that a one-unit increase in performance-based logistics (PBL) of enterprises (FRM) provides an improvement of 0.67 units on the quality, growth and efficiency of enterprises.

All the hypothesis, values and results of the t statistic used in testing the hypothesis tests for the structural equation model are given in Table 3.

Table 3. Standardized Parameter Estimates, T Statistics and Hypothesis for the Model Formed Regarding Performance Based Logistics (PBL) Practices of Enterprises and Quality, Growth and Efficiency of Enterprises (FRM).

Hypothesis	Roads	Standardized Parameter Estimation	t statistic	Conclusion
H1	(PBL) → (FRM)	0,57	8,09	Verified
H2	(PBL) → (FRM)	0,29	4,15	Verified
H3	(PBL) → (FRM)	0,54	8,02	Verified
H4	(PBL) → (FRM)	0,67	9,58	Verified

The relationship between performance-based logistics (PBL) and quality, growth and efficiency (FRM) of enterprises is statistically significant, thus confirming the alternative hypothesis. In addition, the values of the fit scales of the hypothesis are given in Table 4 and it is seen that the hypothesis fits the scales at a very good level.

Table 4. The goodness of fit statistics of the Structural Model for the Performance-Based Logistics (PBL) and Quality, Growth, and Efficiency of the Enterprises.

	Structural Model Goodness of Fit Statistics						
	RMSEA	NFI	NNFI	CFI	SRMR	GFI	AGFI
H1	0,075	0,97	0,97	0,98	0,067	0,95	0,91
H2	0,065	0,95	0,96	0,97	0,083	0,94	0,91
H3	0,068	0,97	0,98	0,98	0,074	0,91	0,87
H4	0,069	0,97	0,97	0,98	0,046	0,97	0,92

SUMMARY

Performance-based logistics, which started in the defense industry and especially in the field of aviation in the USA and spread rapidly, has been implemented in the automotive manufacturing and supply industry in Turkey, which is the dynamic power of the private sector outside the defense field and contributes significantly to increasing exports. PBL predisposition was measured using the scales prepared by the USA and the EU for the Turkish automotive supply industry to provide timely, fast, and effective service to the performance-based logistics application and the applicability of performance-based logistics performance measurement parameters. As a result of the study, it was determined by the Structural Equation Model that the automotive and sub-industry is prone to application, and the sectoral readiness is at a high level. Performance-based logistics processes are examined, their differences compared to classical logistics processes, whether cost advantages can be achieved, and their impact on enterprises are tested with statistical techniques.

Recently, the search for cost-effective systems among enterprises worldwide has necessitated choosing the PBL approach. The PBL application includes data and information obtained to analyze and improve the enterprises' logistics operations. These findings help the

enterprises evaluate their current logistics performance and shape future strategic decisions. The studies are used to optimize logistics operations, reduce costs, increase customer satisfaction, and provide a competitive advantage.

The research has investigated the more effective use of systems in the maintenance operation phase with PBL, the faster and more appropriate services provided to the user, and the effect on the efficiency and growth of the leading logistics service provider's central producer enterprises. It is seen that serious advantages have emerged in parallel with the information in the literature.

Today, serious efforts are being made to develop logistics systems sustainably. The PBL approach, one of the recent critical developments in logistics, can maximize the performance results of systems related to readiness.

The PBL strategy is a modern understanding used throughout the life cycle of systems and products, ensuring continuous preparedness and readiness and providing cost advantages. In today's world, where businesses need to be more competitive, PBL practices provide advantages not only for businesses but also for customers. With the spread of PBL awareness in businesses, businesses will be able to compete more effectively in global markets. With long-term and effective PBL contracts, cooperation between the state and the private sector can be improved, which can benefit all stakeholders.

In PBL applications, the economic, socio-cultural, political, and legal conditions of the country should also be taken into consideration. It is considered that the PBL approach, which has been successfully applied in the defense, aerospace, and space industries, should be applied in different sectors, and it should be aimed to expand its applications in sectors such as construction machinery, automotive, and white goods to increase the performance of the main product.

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CHAPTER 6

THE WINDOW OPENING TO THE SKY OF THE FINANCE

WORLD: FINANCIAL LITERACY AND BEHAVIORAL

FINANCE

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INTRODUCTION

Today, financial literacy is becoming increasingly crucial. Individuals without financial literacy struggle to make personal financial decisions and may also refrain from contributing to the economy through financial investments. Finance is a discipline encompassing the management, regulation, and efficient allocation of resources, financial instruments, money, and investment decisions through appropriate institutions, covering all financial markets. The field of finance is dynamic, swiftly responding to the changing economic conjuncture. Due to this dynamism, market participants are expected to act proactively and rationally according to current conditions. In financial science, various mathematical and statistical modeling techniques are employed by market participants to define asset prices, assess risks of all kinds, and analyze their impact. The Capital Asset Pricing Model (CAPM), Arbitrage Pricing Theory (APT), and Efficient Market Hypothesis (EMH) are prominent theories in finance. In academia, finance examines the operational mechanisms of financial institutions, risk distributions, and resource allocation. This study particularly emphasizes the importance of enhancing financial literacy skills among individuals and households, the necessity of efficiently utilizing limited resources, and the impact of behavioral finance on investment decisions.

1. WHAT IS THE CONCEPT OF FINANCIAL LITERACY

In an increasingly globalized world, it is observed that money markets and capital markets are undergoing more change and development than ever before. Particularly, with the rapid advancement of technology in the post-2000 era, the world has assumed a new structure. Wars, global warming issues, pandemics (such as Covid-19), earthquakes, and numerous political challenges deeply affect financial markets and national economies. Undoubtedly, due to rapid technological changes, market participants have greater access to

investment opportunities and financial instruments, while risks also vary depending on market conditions. In a world where risks and uncertainties are increasing every day, making correct decisions and attempting to mitigate risks become more challenging for investors. In such circumstances, individuals without financial literacy may struggle to make sound investment decisions and could potentially miss significant opportunities. To prevent such situations, individuals need to prioritize financial literacy more than ever, which is essential not only for their own benefit but also for contributing value to the national economy.

The crisis that began in the United States in 2008 as the mortgage crisis quickly spread to European countries and had global repercussions. Among the main causes of the crisis, we can cite banks granting excessive credit to individuals without adequately assessing their income status and driven by an increased appetite for profit. Weaknesses in the oversight mechanisms of public institutions and banks seizing this situation as an opportunity also contributed to the inevitable outcome of the crisis. Additionally, low levels of financial literacy among individuals can be considered a significant factor exacerbating risks.

In a world where financial knowledge is crucial, countries with low levels of financial literacy experience crises at more severe levels. Following such crises, consensus has been reached on the necessity to increase individuals' levels of financial literacy, leading countries to implement various projects in this direction.

According to the Organisation for Economic Co-operation and Development (OECD), financial literacy is defined as creating awareness to enhance individuals' financial well-being through making sound financial decisions, and forming knowledge, skills, and attitudes. Another definition found in the literature describes financial literacy as the ability to effectively and securely utilize financial resources throughout individuals' lifetimes. Financial literacy skills are

characterized not only as short-term but also as long-term investment capabilities for individuals (Darıcı, Kutlu, & Kevser, 2023, p.1).

According to Remund, financial literacy in academic studies conducted from the year 2000 to the present is defined in five categories (Remund, 2010, p. 279)

1. Knowledge of financial concepts,
2. The ability to discuss financial concepts/terms,
3. The capability to manage personal finances,
4. The ability to make appropriate financial decisions,
5. Confidence in planning for future financial needs.

In countries where financial literacy is well-developed, trust in financial instruments increases, investors make informed financial decisions, and as the demand for capital markets grows, the path for economic development and progress of nations is paved. In such a scenario, not only do individuals benefit, but the long-term positive impacts on the national economy can also be observed (Potrich, 2018).

In today's changing dynamics, it is evident that even individuals who have received financial literacy education find it challenging to make the right decisions. Factors such as changes in financial markets, types of risks, demographic structure, gender, the country's level of prosperity, and educational status significantly influence individuals' decision-making processes. The lag in financial literacy can be considered a national issue for countries. Due to this, financial literacy needs to be addressed on a societal level and conveyed to all individuals.

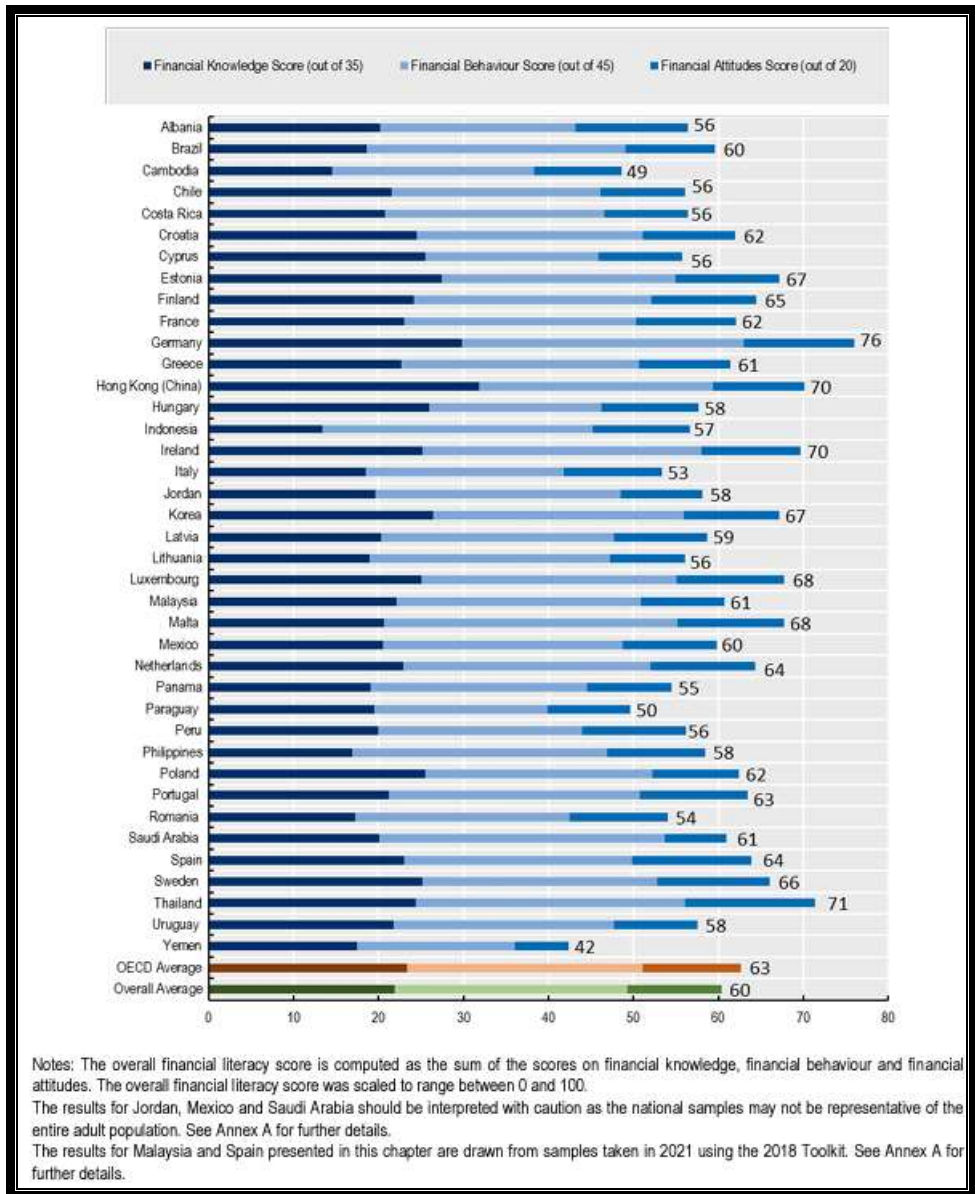
In countries where financial literacy rates are high, individuals are well-versed in managing their income and expenses effectively and efficiently. They can plan the use of credit cards, loans, and borrowing costs in the most optimal way. Individuals can make informed savings and investment decisions to meet their future financial needs.

During economic crises, whether on a micro or macro level, individuals with developed financial literacy exhibit resilience and can

maintain sound investment decisions without succumbing to panic. However, in countries with low financial literacy rates, financial crises are observed to have a more profound impact on societies.

According to the financial literacy report prepared by the Organisation for Economic Co-operation and Development (OECD), the average financial literacy scores of participants from 40 countries are provided below. Among the surveyed countries, the overall average score was 60 out of 100. This rate was observed to be 63 out of 100 among OECD countries.

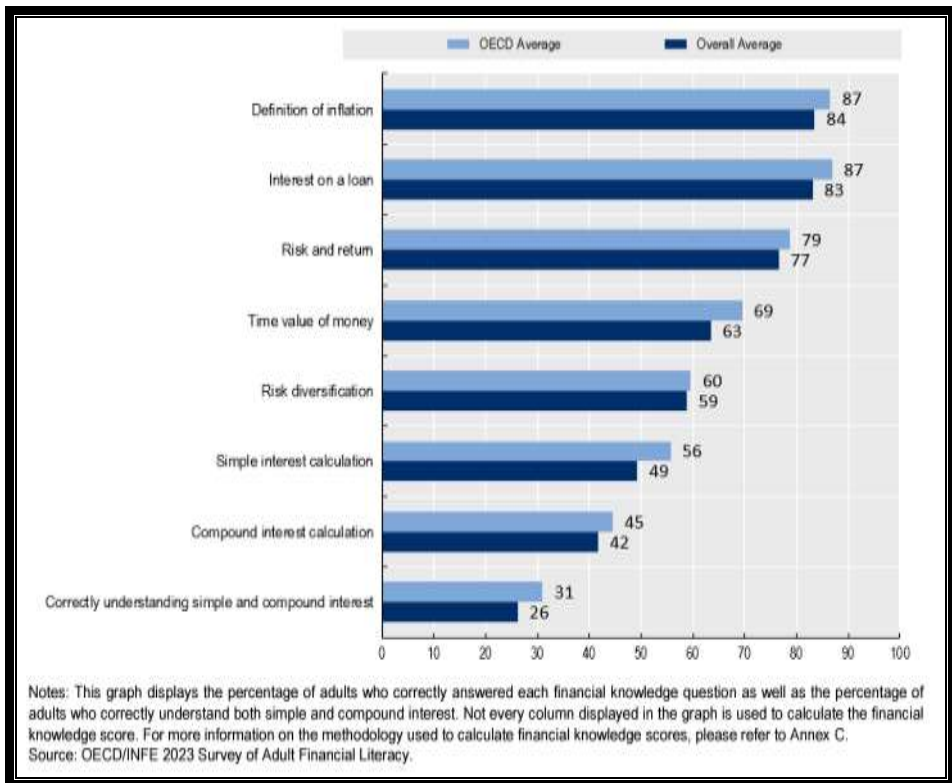
Figure 1: Average Financial Literacy Scores



Source: OECD (2023), "OECD/INFE 2023 International Survey of Adult Financial Literacy"

As seen in Figure 1, the rankings of countries in terms of economy and financial literacy for the year 2023 are presented alphabetically. According to this, while the financial literacy levels of OECD countries are observed to be 63%, the overall average is 60% across all countries. Among the countries, Germany has the highest rate at 76%, followed by Uruguay at 71%, Hong Kong (China) at 70%, and Ireland. According to the aforementioned list, the countries with the lowest literacy rates are Yemen at 42% and Cambodia at 49%. This situation actually mirrors the general cultural literacy and economic development status of the countries. It can be inferred that in technologically advanced and culturally richer countries, individuals tend to have higher financial literacy.

Figure 2: Questions About Financial Knowledge



Source: OECD (2023), "OECD/INFE 2023 International Survey of Adult Financial Literacy"

In figure 2, the participating countries and their economies are averaged overall and within OECD countries to analyze the percentage of adult individuals who correctly answered each financial knowledge question. Accordingly, as seen in the figure, 87% of respondents from OECD countries and 84% from other participating countries correctly identified the definition of inflation. Again, looking at the figure, the lowest accuracy levels were for the simple and compound interest questions. These questions received correct answers from 31% of respondents in OECD countries and 26% from other participating countries. This figure indicates that inflation, which negatively affects national economies and directly impacts individuals and businesses, is more widely understood by societies because it directly influences purchasing power and individual incomes. In contrast, the lower accuracy rates for simple and compound interest questions suggest that these concepts are more relevant to savers, which explains their lower recognition.

Existing studies and future research demonstrate the benefits that can be achieved through financial literacy. Individuals with financial literacy skills can effectively manage their savings and succeed in business planning (Lusardi & Mitchell, 2014, pp. 5-6). Additionally, financially literate individuals tend to be more confident in both their professional and personal lives and have a more positive outlook on life. It has also been observed that employees with higher financial literacy levels use their time more effectively and become more productive. These individuals better understand the benefits offered by their organizations, leading to increased satisfaction levels (Aktan, 2023, p. 104).

The given examples and studies show that increasing financial literacy levels significantly benefits both individuals and the national economy. The sound investments made by financially literate individuals allow for the efficient and effective use of financial markets. This situation is a crucial factor in increasing interest and trust

in the country's financial markets and instruments. A strong financial structure forms the foundation of a strong economy.

2. LITERATURE REVIEW

Sansar (2016), in his study, examined the impact of psychological factors on the investment decisions of market participants. The author stated that classical finance theories are inadequate in explaining market anomalies and, as a result, the behavioral finance approach emerged as an alternative to the efficient market hypothesis. According to Sansar, the psychological states of investors are sufficient to explain their investment behaviors.

Remund (2010), discussed the importance of the widely used concept of financial literacy in the modern era. He indicated that the necessary definition for academics, finance professionals, politicians, consumers, and individuals to manage their finances efficiently and effectively is financial literacy. According to Remund, financial literacy encompasses the knowledge, skills, and confidence that individuals need to manage their finances.

Darıcı, Kutlu, and Kevser (2023), provided insights into financial literacy in their study. They conducted an empirical analysis focused on Turkey. Using the simple random sampling method, they reached 252 individuals aged between 18 and 50 who agreed to participate in the study. According to their findings, the levels of financial literacy differed among individuals aged 18-25, 26-35, and 36-50. Additionally, when examining financial literacy levels regionally, the authors noted that the Marmara and Southeastern Anatolia regions had higher levels of interest compared to the Eastern Anatolia region.

Çalış (2023), conducted a comparative analysis between Turkey and Islamic countries to examine Islamic financial literacy. The author noted that Islamic financial literacy levels are more developed in these countries compared to Turkey. He highlighted that Islamic banking activities are at a low level in Turkey, with participation banks

constituting only 8% of the banking sector. However, this ratio is much higher in countries like Indonesia, Malaysia, and Saudi Arabia.

Aktan (2023), examined the impact of behavioral finance and financial literacy on investment behaviors in his study. The author noted that as financial literacy levels increase, investors can diversify into different investment instruments. Additionally, Aktan mentioned that individuals can mitigate factors such as biases or anxieties that directly affect investments by increasing their financial literacy levels. They also pointed out that individuals who feel inadequate in financial literacy tend to rely more on investment advice from family, friends, and acquaintances.

Besler et al. (2023), discussed how phenomena like herd behavior disrupt market equilibrium, and individuals choose short-term or long-term investment instruments based on their levels of financial literacy. The authors also emphasized the importance of making sound financial decisions for both individuals and national economic development.

Köroğlu et al. (2022), discussed how systematic crises like the COVID-19 pandemic create instability and uncertainty, which in turn affect investors' psychologies and thus their investment behaviors. In their study, the authors directed online survey questions to examine the personal investment behaviors of 384 individuals. According to their findings, investors during the pandemic showed a greater inclination to avoid uncertainty and risks, thus turning to low-risk and low-income investment instruments. The research also indicated that women, individuals aged 56 and older, retirees, and those living with family tended to avoid risks and uncertainties more.

3. WHAT IS THE CONCEPT OF FINANCIAL BEHAVIORS

Behavioral finance was introduced by Fama in 1960 as a critique of the Efficient Market Hypothesis and as an example of weak-form market efficiency. Its recent popularity can be attributed to the 2008

mortgage crisis. The impact of human emotions and perceptions on mortgage pricing actually highlights the influence of human emotions on financial markets. Building on this theory, it is observed that investors do not always behave rationally, contrary to classical financial models, and often act based on their emotions. Additionally, psychological states, anxieties, biases, intuitions, and feelings are seen to lead investors away from rationality (Sansar, 2016, p. 137).

Literature continually explores studies on financial literacy and behavioral finance. Research indicates that individuals' psychological or other behavioral habits significantly influence their investment decisions. Individuals experiencing intense stress, anxiety, or pressure are observed to make decisions that are less rational and informed. Moreover, individuals with low levels of financial literacy often lack developed decision-making mechanisms and struggle to make sound investment choices. Furthermore, individuals with low financial literacy tend to shy away from perceived risky financial instruments like stocks or financial derivatives due to a lack of confidence. This reluctance may prevent them from seizing important investment and income opportunities.

Reviewing the literature reveals that individuals with financial literacy tend to choose different investment instruments compared to those without financial literacy. This observation underscores a direct relationship between financial literacy and investment behaviors. For example, individuals educated in financial literacy may include stocks in their portfolios, whereas those without financial literacy may perceive stocks as highly risky and unsuitable for investment (Aktan, 2023, p. 106).

4. CONCLUSION AND EVALUATION

Due to the rapid advancement of technology in today's world, risks and uncertainties are increasing day by day. Risks are sometimes foreseeable, but at other times, they may be unpredictable or impossible

to forecast. The key issue here is for individuals to access the right financial instruments at the right times when making investment or savings decisions during crises or uncertain periods. To possess this capability, individuals need to have a developed level of financial literacy and sufficient education. Otherwise, individuals may panic and make incorrect decisions, leading to the loss of their investments during uncertain times. This outcome would have negative consequences both for individuals and for the national economy.

Financial markets worldwide exhibit a highly dynamic and fragile structure. Unexpected political statements, natural disasters, economic crises, or public announcements that do not meet investors' expectations can swiftly alter the dynamics of financial markets. Particularly in developing and fragile countries like Turkey, markets are observed to be more volatile and susceptible to risks at a faster rate. This phenomenon has various causes, but a significant factor could be the insufficient level of financial knowledge among individual investors, who are key players in the market. Additionally, it is understood that in financial markets, where participants are expected to make rational decisions, a wrong decision can adversely affect both the investor and subsequently the national economy. Participants possess market-making characteristics, and making correct investment and financial decisions can significantly contribute to the development of the national economy.

In countries with advanced economies and high financial literacy, individuals tend to trust financial markets more and show a greater inclination towards financial instruments. As investors' knowledge levels increase, instruments perceived as risky, such as stocks or leveraged financial derivatives, may be more preferred. However, in countries with low financial literacy, individuals are often either hesitant or completely closed off to investing in these instruments. Factors such as stress, anxiety, age, gender, employment status,

retirement plans, among others, are known to significantly influence their behavior and, consequently, their investment decisions.

Individuals looking to invest their savings exhibit psychological behaviors when choosing between various instruments such as currencies, stocks, bonds, or low-risk short-term money market instruments versus long-term high-risk capital market products. These behaviors often stem from their confidence or lack thereof in understanding the relationships between risks and returns of these products at a sufficient level. Individuals with high levels of financial literacy tend to make more rational decisions during crisis periods, avoiding panic, whereas those with lower financial literacy experience more stress and anxiety, directly impacting their investment decisions.

As a result, while financial and non-financial institutions and organizations play a crucial role in the development of the national economy, individual investors are equally influential and important. To foster economic development, greater emphasis needs to be placed on financial literacy and behavioral finance in our country. It is essential for stakeholders from both the public and private sectors, including universities, academics, and other relevant entities, to increase financial literacy education. This can be achieved through enhanced training programs, seminars, and panels held at various intervals to reach a broader audience.

The more prevalent these educational efforts are in our country, the more effectively individuals can manage their savings in challenging conditions, leading to more efficient use of resources and returns that contribute to the development of our national economy. It should be noted that behavioral issues among individual investors, such as stress and anxiety, often stem from information asymmetry, and increasing levels of education and financial literacy can mitigate these negative effects. Ultimately, efforts should focus on enhancing education and financial literacy levels to reduce the adverse impacts of

behavioral biases among individual investors and thereby promote overall economic growth.

SUMMARY

In this study, an evaluation has been conducted on the effectiveness of financial literacy in influencing individuals' investment decisions. The study also includes an assessment of financial literacy levels across countries. The extent to which individuals correctly answered questions designed to measure their financial knowledge, which types of questions they answered more accurately, and the reasons for discrepancies in their responses were analyzed. The results of our study indicate that there is a positive correlation between individuals' levels of financial literacy and their investment decisions. As individual investors' financial literacy levels increase, they demonstrate a greater ability to analyze the relationship between risk and expected returns. This suggests that individuals with higher financial literacy may be more inclined to choose riskier, yet potentially higher-yielding investments compared to those without such education.

It is emphasized that the improvement of financial literacy not only benefits individuals but also contributes to the development of national economies and financial markets. Furthermore, behavioral finance explains how individuals based on factors such as gender, age, occupation, and stress factors make investment decisions. Accordingly, individuals with higher financial literacy tend to exhibit lower stress and anxiety levels, enabling them to make more rational investment decisions, especially during crises and uncertainties. Our study concludes that the lack of financial literacy education is a national issue for many countries and recommends that education and incentives aimed at increasing individuals' financial literacy levels would benefit them in the short term and contribute to the development of the country's economy in the long term.

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CHAPTER 7

BITCOIN AND MACROECONOMIC VARIABLES: AN ECONOMETRIC APPROACH TO THE GERMAN ECONOMY

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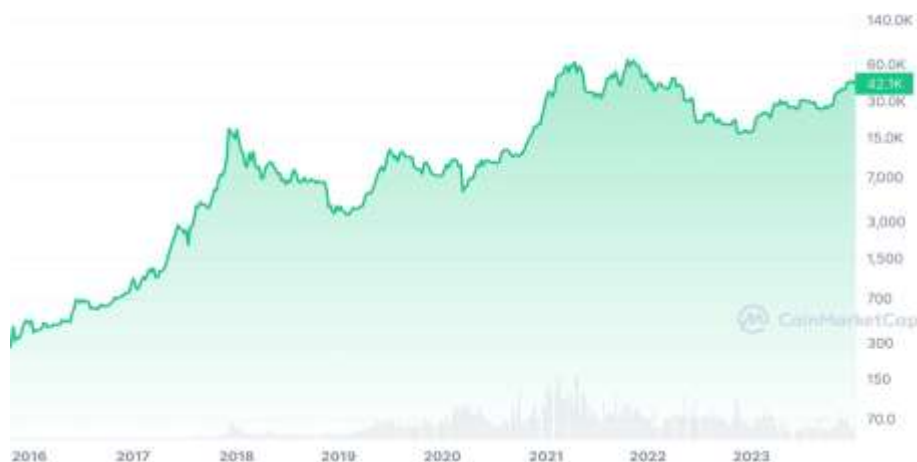
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INTRODUCTION

Technological advances and the gains brought by the globalization process have changed the world's perception of "money" and fiat money has been replaced by cryptocurrencies over time. Therefore, it is of great importance to understand the impact of cryptocurrencies on national economies. The impact of Bitcoin, the first example of cryptocurrencies, on economic indicators such as deposit interest rates, inflation, and gross domestic product is informative about the future of national economies. As a result of Böhme et al. (2015) research, it is emphasized that Bitcoin is not only vital for the functioning of financial markets but also plays an important role in the reconstruction of economics, law, and social status.

Cryptocurrencies were first recognized in 2008 with the article "*Bitcoin: A Peer-to-Peer Electronic Cash System*" in 2008 and started to be used as an investment tool by the whole world. Therefore, Bitcoin was recognized as the first decentralized cryptocurrency and became widespread as the leader of cryptocurrencies. According to CoinMarketCap (CMC), as of April 2024, Bitcoin (BTC) has a total market capitalization of \$1,252,762.417 and a current price of \$63,542.57. Figure 1 shows the price change of Bitcoin over the years.

Figure 1. Price Change of Bitcoin Between 2016 and 2023 (USD)



Source: (CoinMarketCap, www.coinmarketcap.com (07.05.2024)).

Figure 1, which shows the 8-year price fluctuation of Bitcoin, shows that BTC, which gained upward momentum in 2016, tested the highest price in its history with \$17,462.1 in January 2018. Bitcoin, which fell sharply due to the effect of earnings sales, lost value throughout the year and fell to \$3,544.76. In 2019, BTC, which showed bullish signals again, reached \$9,687 in January 2020, but was negatively affected by the Covid-19 pandemic and lost value again. The increased interest in the cryptocurrency market as of October 2020 during the pandemic caused the price of Bitcoin to increase, reaching its highest level in the last months of 2021 and having a price of \$64,863.98. BTC, which then fell with earnings sales, gradually rose again in 2023 and was listed on the market at \$42,542.13.

Bitcoin is used both as an alternative payment system and as a new asset and portfolio diversification for investors in various countries. As Chen et al. (2020) argue, Bitcoin wallets and cryptocurrency exchanges are increasing the participation of individuals in the financial system, especially in developing countries. Bitcoin's impact on the world is felt in many areas, from changes in economic systems to changes in social structures.

1. GERMANY'S APPROACH TO BITCOIN

The existence of cryptocurrency has been recognized by many countries, but their perspectives on cryptocurrency vary. Countries such as Germany, Canada, Italy, and Switzerland have a supportive policy, recognizing that cryptocurrency is legal. On the other hand, countries such as Afghanistan, Macedonia, and Pakistan have followed restrictive policies by declaring cryptocurrency illegal (Global Legal Research Center, 2018).

The legalization of cryptocurrency in Europe first started in Germany. New provisions regarding cryptocurrency were added to the German Banking Act (Kreditwesengesetz/ KWG) and the law entered into force in January 2020. Accordingly, the management and custody

of crypto assets in Germany is defined as "Crypto Custody Business". The German Banking Regulation and Supervision Agency (BaFin) requires exchanges to obtain a license to provide cryptocurrency services. These licenses are required to securely store, manage and transfer crypto assets. Cryptocurrency exchanges operating without a license from the German government are considered to have committed a criminal offense under Article 54 of the German Banking Act (Virtual Currency, 2020).

The German Ministry of Finance has stated that cryptocurrencies held for more than one year are exempt from tax if they are sold. This tax exemption is intended to encourage the long-term holding of digital assets. On the other hand, Germany enacted a law in August 2021 to popularize cryptocurrency investment. According to this law, it allowed institutions to invest 20% of their internal investment funds in crypto assets. This law theoretically creates an investment potential of 350 billion Euros (Bruchwitz and Sartory, 2022). With these regulations, Germany aims to adapt to innovations, protect cryptocurrency investors, and keep financial stability in balance.

2. LITERATURE

There are many studies analyzing the relationship between Bitcoin and macroeconomic variables in the literature. In the related literature, it is possible to come across studies covering different periods and using various data and analysis methods. The first paper that analyzes the relationship between Bitcoin and macroeconomic variables is Baur et al. (2015). In their study, Baur et al. compared the virtual asset Bitcoin with traditional assets such as stocks, bonds, and commodities and concluded that there is no correlation between these assets. In another study, Dyhrberg (2016) examined the hedging properties of Bitcoin for investors and found that Bitcoin can be included in the portfolio to mitigate the negative effects of possible risks occurring in national economies. Selmi et al. (2018) examined whether Bitcoin is used as a

hedging instrument against macroeconomic variables, especially interest rates. As a result of the study, they found that Bitcoin prices are affected by changes in interest rates and that Bitcoin is sensitive to the economic conditions of countries.

One of the studies in the literature, Al-Khazali et al. (2018) analyzed the effects of economic news flow in countries on gold and Bitcoin and concluded that Bitcoin is more sensitive than gold. Therefore, they found that gold is a safer investment instrument than Bitcoin. Basher and Sadorsky (2022) prove that interest rates, inflation and market fluctuations significantly affect Bitcoin prices. They emphasized that analyzing Bitcoin prices is used in asset allocation. As a result of the study, Bitcoin was found to be a substitute for gold to hedge against financial risks.

3. DATA SET AND ANALYSIS

In this study, the relationship between the first example of cryptocurrency, $\% \Delta \text{BTC}/\text{EUR}$, and the rates of change in Germany's deposit interest rate ($\% \Delta \text{DPR}$), inflation ($\% \Delta \text{HICP}$), and gross domestic product ($\% \Delta \text{GDP}$) is investigated with quarterly data. For this reason, 44 quarterly statistics of the variables covering the 2013Q1-2023Q4 periods and the E-Views program are used in the analysis. In addition, BTC/EUR data were obtained from Investing.com, while DPR, HICP, and GDP data were obtained from the European Central Bank (ECB) Data Portal. The econometric model of the relationship between Bitcoin and Germany's economic indicators is as follows:

$$\% \Delta \text{BTC}/\text{EUR}_{it} = \alpha_i + \beta_1 \% \Delta \text{DPR}_{it} + \beta_2 \% \Delta \text{HICP}_{it} + \beta_3 \% \Delta \text{GDP}_{it} + \varepsilon_{it}$$

In the analysis part of the study, firstly, the stationarity of the series is analyzed by Augmented Dickey-Fuller (ADF) unit root test. The results of the ADF unit root test are given in Table 1.

Table 1. Augmented Dickey-Fuller Unit Root Test Results

	Level (Constant and Trend)		First Difference (Constant and Trend)	
	ADF Values	Probability Values	ADF Values	Probability Values
BTC	-3,5007	0,0529	-4,7253	0,0024
DPR	0,3341	0,9982	-4,4201	0,0059
HICP	-0,8558	0,9500	-6,0305	0,0001
GDP	3,1546	1,0000	-9,2175	0,0000

Note: Critical values for the ADF unit root test are obtained from MacKinnon (1996).

Table 1 shows that all variables were first tested for stationarity at the level and then at first difference. According to the ADF unit root test, at 5% significance level, all variables are stationary in their first differences, i.e. I(1). In this case, since all variables are stationary in the first difference, cointegration test should be performed to check whether there is a long-run relationship between the variables. To conduct the Johansen-Juselius (1990) cointegration test, the lag length of the VAR model should be determined first. In this context, the results of the analysis are presented in Table 2.

Table 2: VAR Analysis Lag Length Measurement

Information Criteria /Delays	LR	FPE	AIC	SC	HQ
0	NA	4,85e+08	31,3519	31,5208	31,4130
1	399,0562	1218,383	20,7503	21,5948	21,0557
2	68,5914	3033,799	19,3377	20,8577*	19,8873
3	29,4173	2427,283	19,0482	21,2437	19,8420
4	40,1164*	1077,872*	18,1040*	20,9751	19,1421*

Note: * denotes the optimal lag length.

Considering the information criteria LR, FPE, AIC, SC and HQ, the appropriate lag length is chosen as 4 and then Johansen-Juselius (1990) cointegration test is conducted. The results are presented in Table 3.

Table 3: Johansen Cointegration Test Results

Eigenvalue	Trace Statistic	5% Critical Value	Probability Value	Hypotheses
0,7106	116,3345	47,8561	0,0000	None
0,5276	67,9765	29,7970	0,0000	At most 1
0,4095	38,7274	15,4947	0,0000	At most 2
0,3725	18,1793	3,8414	0,0000	At most 3
Eigenvalue	Maximum Eigenvalue Stat.	5% Critical Value	Probability Value	Hypotheses
0,7106	48,3579	27,5843	0,0000	None
0,5276	29,2491	21,1316	0,0029	At most 1
0,4095	20,5481	14,2646	0,0045	At most 2
0,3725	18,1793	3,8414	0,0000	At most 3

In Table 3, both the trace test and the maximum eigenvalue test at 5% significance level indicate that there are 4 cointegration relationships between the series. Therefore, this implies that the variables in the study have an impact on each other in the long run. In cointegration analyses, Engle-Granger's (1987) Vector Error Correction Model (VECM) analysis should be performed in case of short-term imbalances among the series. The error correction parameter, which represents one lagged value of the error terms, keeps the model dynamics in equilibrium and forces the variables to converge toward the long-run equilibrium level. VECM results are presented in Table 4.

Table 4: VECM Analysis Results

Variables	Coefficients	Standard Error	T Statistic
BTC	-0,3372	(0,0562)	[-6,3138]
DPR	-0,0352	(0,182)	[-1,9247]
HICP	-0,0156	(0,0085)	[-1,8681]
GDP	-0,0124	(0,0109)	[-1,1362]

Note: Since the number of observations in the study is 44, the T table value corresponds to 1.96 at 5% significance level.

Error correction coefficients are expected to be negative and significant. This condition implies that the cointegration relationship is significant for the model. Table 4 shows that the coefficients of all variables in the model have negative values. When the coefficients are negative, it means that the short-term shock effect in the variables continues to diminish and will converge back to the long-run equilibrium. In the table above, the error correction coefficient is statistically significant at -0,3372. According to the formula $\frac{1}{|HDK|}$, the result of $\frac{1}{|-0,3372|}$ is approximately 3 periods. Accordingly, short-term fluctuations in variables converge to the long-run equilibrium in approximately 3 quarters. Whether the coefficient results of the variables are statistically significant or not is understood by looking at the T statistic values of the variables. Considering the T statistic in Table 4, it is seen that the calculated value of T is 6,3138 in absolute value. Based on the T table value of 1,96 at 5% significance level, it is determined that the coefficient is statistically significant within the scope of the equation $6,3138 > 1,96$. Toda-Yamamoto causality test was applied to determine the direction and strength of the causality relationship between the series and the results are presented in Table 5.

Table 5: Toda-Yamamoto Causality Test Results

Hypothesis	$k + d_{max}$	Probability Value	Causality Decision
HICP \Rightarrow BTC	1+4=5	0,0005	Positive
BTC \Rightarrow HICP	1+4=5	0,0000	Positive
DPR \Rightarrow BTC	1+4=5	0,0000	Positive
BTC \Rightarrow DPR	1+4=5	0,0000	Positive
GDP \Rightarrow BTC	1+4=5	0,0000	Positive
BTC \Rightarrow GDP	1+4=5	0,0000	Positive

Note: In Table 5, arrows indicate the direction of the analyzed variables under the null hypothesis of no causality relationship. "k" indicates the appropriate lag length and " d_{max} " indicates the maximum degree of integration.

Table 5 shows that there is bidirectional causality between the dependent variable BTC and the explanatory variables HICP, DPR and GDP at 5% significance level. In econometrics, 5% significance level indicates that the results are statistically significant and reliable with 95% confidence level. Therefore, changes in Germany's HICP, DPR and GDP ratios have a significant impact on BTC, and BTC has an impact on these economic indicators.

In the context of BTC and HICP variables, during periods of high inflation in Germany, investors may turn to alternative investment instruments such as BTC and increase the demand for BTC. Likewise, fluctuations in BTC prices may affect inflation expectations in Germany. In the case of BTC and DPR variables, it is concluded that changes in Germany's deposit interest rates will affect Bitcoin. Germany's Economic growth (GDP) may increase the demand for BTC, as investors may take more risks during periods of economic growth. At the same time, we can conclude that the adoption rate of BTC can also affect economic growth.

It is important for the accuracy of the research that the models examined in the study do not pose problems within the scope of changing

variance, multicollinearity, normality, and autocorrelation tests. Therefore, as a result of the diagnostic tests applied to the variables, it was determined that there were no problems in the model.

4. SUMMARY

In this study, to contribute to the literature, the relationship between the deposit interest rate (DPR), inflation (HICP), and gross domestic product (GDP) change rates, which are the economic indicators of Bitcoin and Germany, is investigated with quarterly data for the period 2013Q1-2023Q4. In the analysis, firstly, ADF unit root test was performed and it was understood that the variables were stationary at first differences, not at level. Then, lag length was determined and Johansen's (1990) cointegration test revealed that there are 4 cointegration relationships between the series. In addition to the fact that the variables affect each other in the long run, it was concluded that in short-term fluctuations, the variables approached equilibrium in about 3 quarters, that is, within 9 months. The Toda-Yamamoto causality test reveals that there is a bidirectional link between all variables, which means that one variable affects the other variable. The German economy and BTC are highly sensitive to each other.

It should be emphasized that the study sample is only for the period 2013Q1-2023Q4. The bidirectional causality obtained within the specified period shows that Bitcoin has high volatility in the German economy and is strongly affected by macroeconomic changes. Individuals conducting financial transactions in the German market should diversify their portfolios against these risks and develop risk management strategies. Germany's central bank and economic management should plan monetary policy and other economic measures, taking into account the impact of Bitcoin on economic indicators. On the other hand, academic research should be encouraged to examine the relationship between Bitcoin and Germany's macroeconomic indicators

in more detail. These studies could provide a deeper understanding and guide future policy.

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CHAPTER 8

THE RELATIONSHIP BETWEEN RENEWABLE ENERGY TECHNOLOGIES, ENERGY INNOVATION, AND CO₂: A KONYA BOOTSTRAP CAUSALITY ANALYSIS

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INTRODUCTION

Environmental degradation has increased from the past to the present, becoming a major issue, particularly in developing and underdeveloped countries. These environmental degradations have been shown to have a long-term negative impact on countries' GDP. As a result, environmental issues have been included in the economics literature, and policy proposals have begun to be made in this regard. Renewable energy is widely recognized as having significant environmental and economic implications. The globe has grown increasingly interested in energy as a means of supporting economic growth and improving living conditions. However, the use of nonrenewable energy, particularly fossil fuels, to meet these demands has become the leading driver of environmental damage. This cycle can be described in terms of increases in greenhouse gases caused by global warming. Carbon emissions contribute significantly to greenhouse gas emissions. Because of these drawbacks, interest in renewable energy, an alternative energy source, has begun to shift. In light of this knowledge, E7 countries were chosen as the study's panel. The reason for selecting this group of countries is that they have a high rate of economic development, have become central countries in terms of production, and are attracting attention for their carbon emissions. The analysis was conducted using Eviews, Stata, and the Gauss econometric package tools.

The remaining sections of the project will include literature reviews on environmental pollution and econometric analysis. The reports will be interpreted in tables, and a conclusion will be provided. The study is motivated by the absence of previous research on the association between variables and environmental pollution in E7 countries throughout the relevant time period.

1. REVIEW OF THE LITERATURE

A survey of the environmental literature finds that the environmental Kuznet curve (EKC) hypothesis is used in numerous research to investigate the possible relationship between CO₂ emissions and economic growth. Similarly, the influence of FDI on CO₂ emissions with the PSH (pollution haven hypothesis) and PHH (pollution halo hypothesis) hypotheses is widely discussed in the literature. Furthermore, academics have conducted econometric and theoretical analyses of the link between renewable energy and CO₂ emissions.

In the results, some investigations confirm the EKC-PSH-PHH hypothesis, while others conclude that it is invalid. Including renewable energy in the literature is intended to lessen environmental pollution. In general, renewable energy reduces CO₂ emissions, which are considered pollutants, whereas non-renewable energy increases CO₂ emissions and harms the environment. All of these findings underscore the value of renewable energy.

Grossman and Krueger (1991), one of the first investigations on the EKC hypothesis, discovered that the hypothesis is valid by utilizing the panel data approach for the years 1977, 1982, and 1988 with 32 selected countries. Shafik (1994) examined the period 1960-1990 in 149 selected nations. Using the fixed effects method in panel data analysis, he discovered that the EKC hypothesis was correct. Jaunky (2011) examined GMM, panel VECM, and causality analysis for 36 high-income nations from 1980 to 2005. Jaunky found that the EKC hypothesis is invalid. Similarly, He et al. (2017) conclude that the Driscoll-Kraay estimator's results for the period 1995-2013 do not support the EKC hypothesis.

Tobey (1990), one of the pioneering studies on the PSH-PHH hypothesis, selected 23 developed countries from 1970 to 1984. The study, which used HOV cross-sectional dependence and OLS analysis, concludes that the influence of tight environmental rules on

investments is immeasurable, so no assumptions can be drawn about the PSH. Mani and Wheeler (1997) discovered that from 1960 to 1995, the production and exports of pollution-causing products increased in developing countries while decreasing in OECD countries. Gökalp and Yıldırım (2004) conducted a time series analysis of the Turkish economy spanning 1989-2001. As a result, they determined that the PSH is invalid. Karaca (2012) conducted balanced panel data analyses for 42 intermediate and high-income developing nations and 24 rich countries from 1995 to 2008. As a consequence of the investigation, he discovered that the PSH, which he tested with many factors, applies to both emerging and developed countries. Çeştepe and Ergün Tatar (2023) conducted a cointegration analysis on PHH in the Turkish economy during 1990-2019. They decided that the hypothesis was incorrect. Hacımamoğlu (2022) examined BRICS and Turkey from 1992-2017. The panel data analysis results show that both EKC and PSH are legitimate.

Baloch et al. (2019) determined the 1990-2015 year range for their investigation of the association between renewable/non-renewable energy availability and environmental pollution in BRICS nations. The study, which used AMG panel data analysis, found that renewable energy sources cut CO₂ emissions, which are considered pollutants. Okumuş (2020) used ARDL to examine the Turkish economy from 1968 to 2014 and found that non-renewable energy consumption increases CO₂ emissions while renewable energy consumption reduces CO₂ emissions in the short run. Leitão and Lorente (2020) analyzed 28 EU member states from 1995 to 2014. They determined that renewable energy mitigates environmental deterioration and climate change. Çetintaş and Aydın (2022) investigated the relationship between environmental pollution and economic growth in terms of renewable energy in OECD nations from 1995-2018. The research was conducted using a smooth transition panel regression model. The findings demonstrate that increasing the usage of renewable energy is critical to

environmental protection. Altıntaş (2022) analyzed energy innovation performance in European countries using the Mabac and Marcos technique. According to his analysis, the top three countries with the best global energy innovation performance are Finland, Denmark, and Sweden, while the bottom three are Poland, Greece, and Estonia.

2. DATA SET, AND METHOD

The study uses CO₂ as a surrogate for environmental pollution. This variable was acquired from the World Bank's database. Renewable energy technologies are incorporated into the model. Renewable energy technologies are sourced from IRENA, while energy innovation is drawn from the IEA database. The study covers E7 countries from 2001 to 2020. However, given the availability of data on these factors, Indonesia and India were excluded from the panel, leaving just Brazil, China, Mexico, Russia, and Turkey. The statistics are evaluated annually. The study includes two models. First, the first model is created to investigate the causal relationship between environmental degradation and renewable energy advances. The second model is then developed to explain the causal relationship between energy innovation and renewable energy technologies. The models are as follows:

$$CO2_{it} = \beta_0 + \beta_1 RET_{it} + u_{it} \quad (1)$$

$$RET_{it} = \beta_0 + \beta_1 EI_{it} + u_{it} \quad (2)$$

In equation 1, CO₂ emissions are the dependent variable in the model, while RET is the independent variable. In Equation 2, RET is the dependent variable and EI is the independent variable. In addition, 'β₀' stands for the constant term, 'u' for the error term, 'i' for nations, and 't' for the time (20). Table 1 provides meanings for these data.

Table 1: Data Description

Variables	Description	Source
CO2	CO2 Emissions (Kg per 2015 US\$ of GDP)	World Bank*
RET	Renewable Energy Technologies The Average of Renewable Hydropower and Onshore Wind Energy Values (On-grid Electricity)	IRENA**
EI	Energy Innovation (Clean Energy Patents)	IEA***

Note: *: <https://data.worldbank.org/indicator>; **: <https://www.irena.org/Data/View-data-by-topic/Capacity-and-Generation/Technologies>; ***: <https://www.iea.org/data-and-statistics/data-tools/energy-technology-patents-data-explorer> (Access: 10.05.2024)

In the analytical portion, the BP LM (1980), Pesaran, Ullah, and Yamagata LMadj (2008), and Pesaran CD (2004) tests were employed to assess the cross-sectional dependence of the variables as a group. In addition, the Pesaran CD (2004) test is utilized to examine each series separately. The null hypothesis for these tests is that there is no cross-sectional dependency, while the alternative hypothesis is that there is cross-sectional dependence.

When there are more observations than cross-sections, the BP LM (1980) test is preferred. The cross-section dependence test equations are as follows:

$$H_0 = \rho_{IJ} = \text{Corr}(u_{ij}, u_{jt}) = 0 \rightarrow (i \neq j) \quad (2)$$

$$LM = \sum_{i=1}^{N-1} \sum_{j=i+1}^N \hat{\rho}_{ij}^2, \chi_{N(N-1)/2}^2 \quad (3)$$

The Pesaran CD (2004) test is applicable when both the number of cross-sections and the number of observations exceed the number of cross-sections.

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^N T \hat{\rho}_{ij} \right) \rightarrow N(0,1) \quad (4)$$

Pesaran et al. (2008) created the bias-corrected LM_{adj} cross-sectional dependence test, which is also recommended in heterogeneous panels.

$$LM_{adj} = \sqrt{\frac{2}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^N \frac{(T-k) - \mu_{Tij}}{v_{Tij}^2} \rightarrow N(0,1) \quad (5)$$

The Delta test, created by Pesaran and Yamagata (2008) and based on Swamy (1970), is used to assess the homogeneity of slope coefficients. The null hypothesis states that the coefficients are homogenous, whereas the alternative is heterogeneous. The statistics of the test, which may be used with both big and small samples, are as follows:

$$\tilde{\Delta} = \sqrt{N} \left(\frac{N^{-1} \tilde{S} - k}{\sqrt{2k}} \right) \quad (6)$$

$$\tilde{\Delta}_{adj} = \sqrt{N} \left(\frac{N^{-1} \tilde{S} - E(\tilde{z}_{IT})}{\sqrt{\text{var}(\tilde{z}_{IT})}} \right) \quad (7)$$

Finally, Konya (2006) panel causality analysis, which is regarded appropriate for heterogeneous panels with cross-sectional dependence based on application results, was performed. The Konya (2006) bootstrap causality models for the two-variable model are listed below. Equations (9 and 12) in the first model and (15 and 18) in the second model are approximated using SUR.

Model 1:

$$CO2_{1,t} = \alpha_{1,1} + \sum_{l=1}^{mly1} \beta_{1,1,l} CO2_{1,t-l} + \sum_{l=1}^{mlx1} \theta_{1,1,l} RET_{1,t-l} + \varepsilon_{1,1,t} \quad (8)$$

$$CO2_{2,t} = \alpha_{1,2} + \sum_{l=1}^{mly1} \beta_{1,2,l} CO2_{2,t-l} + \sum_{l=1}^{mlx1} \theta_{1,2,l} RET_{2,t-l} + \varepsilon_{1,2,t} \quad (9)$$

$$CO2_{N,t} = \alpha_{1,N} + \sum_{l=1}^{mly1} \beta_{1,N,l} CO2_{N,t-l} + \sum_{l=1}^{mlx1} \theta_{1,N,l} RET_{N,t-l} + \varepsilon_{1,N,t} \quad (10)$$

and

$$RET_{1,t} = \alpha_{2,1} + \sum_{l=1}^{mly2} \theta_{2,1,l} RET_{1,t-l} + \sum_{l=1}^{mlx2} \beta_{2,1,l} CO2_{1,t-l} + \varepsilon_{2,1,t} \quad (11)$$

$$RET_{2,t} = \alpha_{2,2} + \sum_{l=1}^{mly2} \theta_{2,2,l} RET_{2,t-l} + \sum_{l=1}^{mlx2} \beta_{2,2,l} CO2_{2,t-l} + \varepsilon_{2,2,t} \quad (12)$$

$$RET_{N,t} = \alpha_{2,N} + \sum_{l=1}^{mly2} \theta_{2,N,l} RET_{N,t-l} + \sum_{l=1}^{mlx2} \beta_{2,N,l} CO2_{N,t-l} + \varepsilon_{2,N,t} \quad (13)$$

Model 2:

$$RET_{1,t} = \alpha_{1,1} + \sum_{l=1}^{mly1} \beta_{1,1,l} RET_{1,t-l} + \sum_{l=1}^{mlx1} \theta_{1,1,l} EI_{1,t-l} + \varepsilon_{1,1,t} \quad (14)$$

$$RET_{2,t} = \alpha_{1,2} + \sum_{l=1}^{mly1} \beta_{1,2,l} RET_{2,t-l} + \sum_{l=1}^{mlx1} \theta_{1,2,l} EI_{2,t-l} + \varepsilon_{1,2,t} \quad (15)$$

$$RET_{N,t} = \alpha_{1,N} + \sum_{l=1}^{mly1} \beta_{1,N,l} RET_{N,t-l} + \sum_{l=1}^{mlx1} \theta_{1,N,l} EI_{N,t-l} + \varepsilon_{1,N,t} \quad (16)$$

and

$$EI_{1,t} = \alpha_{2,1} + \sum_{l=1}^{mly2} \theta_{2,1,l} EI_{1,t-l} + \sum_{l=1}^{mlx2} \beta_{2,1,l} RET_{1,t-l} + \varepsilon_{2,1,t} \quad (17)$$

$$EI_{2,t} = \alpha_{2,2} + \sum_{l=1}^{mly2} \theta_{2,2,l} EI_{2,t-l} + \sum_{l=1}^{mlx2} \beta_{2,2,l} RET_{2,t-l} + \varepsilon_{2,2,t} \quad (18)$$

$$EI_{N,t} = \alpha_{2,N} + \sum_{l=1}^{mly2} \theta_{2,N,l} EI_{N,t-l} + \sum_{l=1}^{mlx2} \beta_{2,N,l} RET_{N,t-l} + \varepsilon_{2,N,t} \quad (19)$$

In the first model, CO2 emissions indicate environmental pollution, whereas RET represents renewable energy technologies. EI in the second model measures energy innovation. ‘t’ represents the time (2001, 2002,...2021), ‘N’ represents the number of countries (i=1,2,3,4,5), and ‘t’ is the lag duration.

This test is based on the Wald test and Seemingly Unrelated Regression (SUR) estimation, which involves determining bootstrap critical values for each country. The fact that it can be used in heterogeneous panels means that only one hypothesis is not valid for the entire panel. One of the test’s merits is that it allows for the investigation of causation for each cross-section individually. Another advantage is that no a priori tests, such as unit root or cointegration tests, are required. The test can be applied to heterogeneous panels under cross-sectional Konya (2006) used the Schwarz criterion to determine the lag length (Konya, 2006: 979).

3. ECONOMETRIC RESULT

Table 2 shows the results of the cross-sectional dependence and homogeneity tests. According to the test results, the null hypothesis that there is no cross-sectional dependence between the series is rejected for both group and individual results using the BP LM (1980), Pesaran et al. (2008) LM_{adj}, and Pesaran CD (2004) tests. As a result, it is argued that the series has cross-sectional dependence, which means that a shock in one of the E7 countries will affect the other members. According to the Delta and Delta_{adj} tests, the null hypothesis that the slope coefficients are homogeneous is rejected. As a result, slope parameters differ between cross-sections.

Table 2: Cross-sectional Dependence and Homogeneity Test Results

Cross-sectional Dependence						Delta	
As a Group			Individually			Pesaran & Yamagata (2008)	
BP LM (1980)	Statistic	Prob.	CO2	CD-test	Prob.	Delta	
	48.46	0.000		5.02	0.000	Statistic	Prob.
LM _{adj} PUY (2008)	Statistic	Prob.	RET	CD-test	Prob.	Delta _{adj}	
	18.89	0.000		13.83	0.000	9.683	0.000
Pesaran LM CD (2004)	Statistic	Prob.	EI	CD-test	Prob.	Statistic	Prob.
	-2.577	0.010		8.03	0.000	10.826	0.000

Given these findings, the cross-sectional dependence and heterogeneity requirements among the series, which are required by Konya's (2006) panel causality test, are met. The panel causality results are shown in Table 3.

Table 3: CO2 & Renewable Energy Technologies

<i>Konya (2006) Bootstrap Panel Causality Test Result</i>								
Country	Wald	H ₀ :RET→CO2			H ₀ :CO2↔RET			
		Bootstrap CVs			Bootstrap CVs			
		1%	5%	10%	Wald	1%	5%	10%
Brazil	0.004	14.340	10.250	8.691	19.202*	14.853	5.523	4.006
China	19.518*	14.197	8.785	6.541	2.496	10.480	5.529	3.553
Mexico	16.873*	2.222	1.321	0.992	3.996**	4.409	2.015	1.295
Russia	1.050	8.677	6.018	4.681	0.225	22.228	12.810	9.057
Turkey	8.311**	9.638	6.725	5.164	0.120	10.190	4.420	2.654

Note: The null hypothesis is rejected at a significance level of 1% (*) or 5% (**). The Schwarz information criterion is applied. 1000 bootstrap replications are performed to get critical values.

Table 3 shows that the null hypothesis that renewable energy technologies are not the source of CO2 emissions for each cross-section (country) is rejected in China, Mexico, and Turkey. As a result, it is clear that renewable energy technologies have a causal relationship with CO2 emissions, which are deemed to be environmental pollutants in these countries. The null hypothesis, that there is no causal association between CO2 emissions and renewable energy technologies, is rejected with significant significance for Mexico, particularly Brazil.

It can be attributed to Brazil's strong rejection of carbon emission reductions after 2003 (SEEG, 2024). Furthermore, when viewed in relation to the study's time range (2001-2021), these findings are found to be mutually supporting. In this context, CO2 emissions are the driver of renewable energy technologies in Brazil and Mexico. Furthermore, the panel shows a bidirectional causality relationship for Mexico.

Table 4: Renewable Energy Technology & Energy Innovation

<i>Konya (2006) Bootstrap Panel Causality Test Result</i>								
Country	Wald	H ₀ :EI→RET			H ₀ :RET→EI			
		Bootstrap CVs			Bootstrap CVs			
		1%	5%	10%	Wald	1%	5%	10%
Brazil	0.749**	1.396	0.727	0.533	0.503	11.225	5.844	4.270
China	28.415**	30.122	21.550	18.862	0.108	16.595	9.794	8.122
Mexico	0.158	4.093	2.448	1.957	0.377	14.805	7.981	5.710
Russia	0.052	8.500	5.608	4.168	0.030	13.160	6.385	4.420
Turkey	6.589*	4.482	1.783	1.001	3.232	16.203	8.797	6.527

Note: The null hypothesis is rejected at a significance level of 1% (*) or 5% (**). The Schwarz information criterion is applied. 1000 bootstrap replications are performed to get critical values.

Table 4 shows the findings from another research area, the causal relationship between energy innovation and renewable energy technology. According to the findings, the null hypothesis that energy innovation is not a cause of renewable energy technologies is rejected in Brazil, China, and Turkey. As a result, there is a causal relationship between energy innovation and renewable energy technologies in Brazil, China, and Turkey.

SUMMARY

To fulfill the excess consumption caused by the world's rapid population growth, particularly in undeveloped and developing countries, nonrenewable resources are being used. Countries' primary goal is to attain pure growth, therefore environmental problems may be disregarded. Countries are currently pursuing policies that prioritize the environment over other considerations. Renewable energy has begun to be incorporated into research, with the recent inclusion of this problem in the literature, as both carbon emissions reduction and environmentalist policies are on the agenda. This study focuses on the E7 countries. India and Indonesia, however, were unable to participate in the panel due to data availability constraints. As a result, the study includes just Brazil, China, Mexico, Russia, and Turkey. Panel time series analysis is used for these nations from 2001 to 2021. Because the

primary goal of the study is to analyze the causative relationship between the series, Konya's (2006) panel bootstrap causality analysis is used. The study includes two models to determine the causal link between the variables. The first model examines the causation between CO₂ emissions and renewable energy technologies, while the second model investigates the causality between energy innovation and renewable energy technologies. The Konya (2006) test assumes that the series has cross-sectional dependence and that the panel is heterogeneous. As a result, approaches such as unit root, cointegration, and ARDL were not used. The study indicates cross-sectional dependence between the series. Additionally, slope parameters were discovered to be non-homogeneous. As a result, all of the Konya (2006) causality test requirements have been met. According to the study's major findings, renewable energy technologies have a causal relationship with CO₂ emissions in China, Mexico, and Turkey. For Brazil and Mexico, a link between CO₂ emissions and renewable energy technology was discovered. As can be shown, bilateral causality was demonstrated for Mexico, one of the participating countries. According to the results of the second model, there is unilateral causation from energy innovation to renewable energy technologies in Brazil, China, and Turkey. Renewable energy technologies are a key factor of carbon emissions in E7 countries, as is energy innovation. Although there is no bidirectional causation between the general panel and the series for the E7 nations, these countries should be more inclined toward renewable energy technology and energy advances, as well as implement positive policies in this area.

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