INDPOL
INDUSTRIAL POLICY

A Scientific journal dedicated to economic development and industrial policy

Volume: 4 Issue: 2 December 2024 E-ISSN: 2757-9840

Open Access

DergiPark AKADEMİK

OJS OPEN JOURNAL SYSTEMS

E-ISSN: 2757-9840

INDPOL
INDUSTRIAL POLICY

A Scientific journal dedicated to economic development and industrial policy

June 2024 Volume IV Issue II

Industrial Policy (ISSN-2757-9840) is the prime outlet for research on industrial policy and its impact on the society. The INDPOL publishes high quality research on the process of economic and technological development, in particular industrialization. INDPOL is published via OJS and DergiPark platforms. INDPOL is indexed by Google Scholar.

The journal covers a wide range of topics relating to the manufacturing industry and industrial policy including the industrialization process; industrial development, institutions and structural policies that support economic development including the political economy aspects; tools (such as economic planning) and market structures (including monopolistically competitive markets that have a bearing on manufacturing value added and overall economic productivity) and their impact on economic development and industrialization; low and middle income traps; productivity; mechanism design and incentive structures that hinder or foster industrial and economic development; science, technology and innovation strategies and polices (at corporate and national levels) and their impact on economic development; individual and institutional learning processes, education systems, financial institutions, markets and policy, vocational training, third generation, entrepreneurial and industrial universities and their impact on economic development and industrialization; and historical and contemporaneous case studies relating to industrial development.

E-ISSN: 2757-9840

Contents

INDUSTRIAL POLICY
A Scientific Journal Dedicated to Economic Development and Industrial Policy

OPEN ACCESS

Research Article

www.indpol.org

DOI: 10.61192/indpol.1596389

IndPol, 2024; 4(2): 50-58

The Effects of Global Economic Policy Uncertainties on Manufacturing Industry Exports: The Case of Türkiye

Ferdi Akpilic[a], Caglayan Aslan[b] and Erdem Bulut[c]

[a] Ministry of Treasury and Finance, Ankara, Türkiye, ORCID: 0000-0002-7692-4651
[b] Ministry of Trade, Ankara, Türkiye, ORCID: 0000-0002-9907-5189
[c] Ministry of Trade, Ankara, Türkiye, ORCID: 0000-0001-6383-2849

Abstract

In this paper, the relationship between Türkiye's manufacturing industry exports and global economic policy uncertainty (GEPU) is examined using monthly data from 2013:01 to 2023:12. Estimations performed using the ARDL approach indicate that GEPU does not significantly affect manufacturing industry exports in Türkiye. This finding suggests that Turkish manufacturing industry exporters maintain stable and long-term trade relations. Consistent with expectations, foreign demand positively influences exports, while the appreciation of the Turkish Lira has a negative impact. To enhance manufacturing industry exports, it is recommended to strengthen commercial and diplomatic ties, enhance international cooperation, mitigate exchange rate risks through expanded hedging mechanisms, and invest in human capital and technology.

Article History
Received December 4, 2024
Revised December 8, 2024
Accepted December 17, 2024

Keywords
Export, Global Uncertainty, Foreign Demand, Exchange Rate, ARDL

JEL Codes
F10, F14

1. Introduction

In recent years, global political and economic turbulence has significantly increased uncertainty in trade and economic policies (Al-Thaqeb & Algharabali, 2019). The global financial crisis that occurred in 2008 (Fortin et al., 2023), the Arab Spring, which profoundly affected the Middle East, including Türkiye, as well as the rest of the world (Chau et al., 2014), the protectionist measures implemented by U.S. President Donald Trump (Jawadi & Ftiti, 2017), the United Kingdom's Brexit decision (Bissoondeeala et al., 2023), Russia's invasion of Ukraine (Assaf, 2023), migration crises (Donadelli et al., 2019), and the radical policies enacted by central banks (Mumtaz & Ruch, 2023) are among the prominent factors contributing to this uncertainty. This situation is also evident at the micro level in Türkiye. In particular, the migration crisis faced by Türkiye in recent years, trade restrictions imposed by Russia, economic crises, and the policies implemented by the Central Bank are the main sources of uncertainty (Sahinöz & Cosar, 2018). Uncertainty can lead to various adverse outcomes in the economy, ranging from short-term financial fluctuations to long-term structural problems. Consumers, the most fundamental economic units, tend to cut spending and increase savings under uncertainty. This situation impacts economic growth in the short-term directly (Dimitris et al., 2020). Moreover, uncertainty has the potential to increase risk premiums in financial markets, thereby reducing asset prices and wealth (Brogaard & Detzel, 2015). Declining asset prices not only complicate access to credit but also increase financing costs, negatively affecting investments (Gilchrist et al., 2014). The effects of uncertainty on fundamental economic variables, such as consumption, investment, and income, have negative implications for economic growth, development, and income distribution in

CONTACT Erdem Bulut buluterdem@yahoo.com

both the short and long-term (Şahinöz & Cosar, 2018). One of the areas most affected by uncertainty is foreign trade. In today's foreign trade policies, not only traditional variables such as exchange rates and income but also political and economic uncertainties play an active role in shaping trade dynamics (Handley, 2014). As a consequence of uncertainty, firms that are not sure about their future revenues and profits often choose to postpone fix and irreversible investments (Bernanke, 1983). During such periods, entrepreneurs adopt a "wait-and-see" strategy and delay investments (Dixit, 1989; Julio & Yook, 2016), while consumers defer purchases of relatively expensive durable goods (Bertola et al., 2005). The negative effects of uncertainty on fundamental macroeconomic variables such as investment, consumption, income, and financing directly influence international trade flows. Handley and Limão (2015) claims that exporters, who initially face high fixed costs for activities such as market research and feasibility investments, are the first to abandon new investment decisions in uncertain situation. The impact of uncertainty on Türkiye's exports is particularly significant since the country's economic growth dynamics consist of export oriented growth. (Dura et al., 2017). However, 85% of Türkiye's imports consist of intermediate and capital goods approximately. On the other hand this structure poses a disadvantage for Türkiye, it also holds potential advantages. For instance, although Türkiye's exports increased from $152 billion in 2013 to $232 billion in 2023, the share of manufacturing industry exports remained unchanged at 94% during this period. Furthermore, the share of manufacturing industry production in GDP has been approximately 20%. Despite its significant share in total production and exports, the response of manufacturing exports to economic policy uncertainty remains a critical question for Türkiye. This paper sheds light on the relationship between global economic policy uncertainty and Türkiye's manufacturing exports, providing valuable insights and recommendations for policymakers.

2. Literature Review

In current foreign trade literature, uncertainty has emerged as a critical variable. Numerous studies have focused on global trade (Aslan & Acikgoz, 2023; Matzner et al., 2023; Lal et al., 2023; Baley et al., 2020), while others have specifically examined its implications for Türkiye (Kilic & Balli, 2024; Köse & Aslan, 2023; Alacahan and Akarsu, 2017). Country-specific studies indicate that rising economic uncertainties negatively impact export performance and key macroeconomic variables. For instance, Han et al. (2016) demonstrated that increasing economic uncertainty adversely affects China's exports and macroeconomic indicators. In the case of South Africa, Hlatshwayo and Saxegaard (2016) determined that the negative impact of economic policy uncertainty on exports outweighs the positive effects provided by exchange rate advantages. Similarly, Hassan et al. (2018) concluded that economic policy uncertainties in the United States negatively influence its trade flows. However, the impact of increased economic policy uncertainty among the United States' major trading partners on United States foreign trade is relatively limited. In another study concluding that economic policy uncertainty negatively affects United States foreign trade, Krol (2018) argued that imports are more sensible to uncertainty than exports. Analyzing the relationship between global trade and economic policy uncertainty, Tam (2018) showed that economic policy uncertainties in China and the U.S. adversely affect not only these countries' foreign trade but also global trade. Constantinescu et al. (2020) found that a 1% increase in economic policy uncertainty reduces the growth of global goods and services trade by 0.02% and a 1% decline in global trade growth. Aslan and Acikgoz (2021) investigated the effects of global economic policy uncertainty on the export performance of developing countries, highlighting that foreign demand is the primary determinant of exports and that uncertainties adversely affect export activity. Yagis (2024) focused on the impact of economic policy uncertainty on foreign trade in G-7 countries and found a negative relationship between economic policy uncertainty and volume of trade, with declining trade volume further negatively affecting economic growth. Exploring sectoral effects of economic policy uncertainty, Sharma and Paramati (2021) found that raw material trade is the most sensitive to uncertainty in the case of India. Li and Li (2021) demonstrated that increased economic policy uncertainty directly effects China's grain imports negavitely. Examining the trade of high value-added manufacturing products, Zhao (2022) found that increased uncertainty adversely affects trade in high value-added manufacturing goods in both exporting and importing countries. The primary cause of the negative effect in the exporting country is sunk costs, while in the importing country; it is the decline in market demand. Aslan and Açıkgöz (2023) examined relationship between the exports of developing countries and global economic policy uncertainty. They noted that entrepreneurs expected to make larger investments in the production of high technology products are more sensitive to increased uncertainty and may delay their investment decisions. The existing literature includes numerous studies on relationship between uncertainty and trade flows. However, research on the micro-level and sector-specific effects of uncertainty remains limited. Variables such as trade elasticities, value-added shares, input-output linkages, production costs, and demand structure increased sectoral

heterogeneity (Giri et al., 2021). This study fills a significant gap in the literature by examining the response of Türkiye's manufacturing sector exports—an area of critical importance for the country—to economic policy uncertainty.

3. Emprical Framework

3.1 Methodology

In this study, the impact of global economic policy uncertainty (GEPU) on exports was investigated by extending the classical export demand model, and Equation (1) was formulated.

$$LX_t = \beta_0 + \beta_1 Y_t + \beta_2 REER_t + \beta_3 EPU_t + \varepsilon_t \qquad (1)$$

In Equation (1), X_t represents Türkiye's real exports in the manufacturing industry, Y_t denotes the industrial denotes the industrial production index of trading partners countries, $REER_t$ refers to Türkiye's CPI-based real effective exchange rate, and $GEPU_t$ signifies global economic policy uncertainty developed by Baker et al. (2016).

In the model, the industrial production index is used as an indicator of foreign demand. An increase in this value implies that countries are experiencing economic growth and rising incomes, which is assumed to lead to an increase in import demand. In this context, $\beta_1$is expected to be positive. $REER_t$ is generally used as a measure of competitiveness in international markets. An increase in $REER_t$ indicates that the local currency, in this case, the Turkish lira (TRY), has gained value in real terms. This implies that as $REER_t$ rises, the TRY appreciates, making Turkish goods more expensive in international markets. This would reduce the competitiveness of Turkish goods, leading to a negative expectation for β_2. During periods of increased uncertainty, exporters raise their risk perceptions due to unpredictability in future demand, exchange rates, and trade policies. This can negatively affect investment and production decisions, potentially reducing exports. Additionally, when GEPU is high, global demand may contract, and trade partners' import demands may decline. Therefore, GEPU can be considered a limiting factor for exports. Consequently, the coefficient of β_3, is expected to be negative

3.2 Data

The study was conducted using monthly data covering the period from 2013:01 to 2023:12. For Türkiye's manufacturing industry exports, data were obtained from the TURKSTAT database, utilizing the seasonally and calendar-adjusted volume index of exports classified by economic activities (ISIC Rev. 4) in the manufacturing sector. The foreign demand indicator was represented by the seasonally and calendar-adjusted industrial production index of OECD countries, retrieved from the OECD database. Additionally, the seasonally and calendar-adjusted industrial production index of EU countries was obtained from the Eurostat database and used in an alternative model for robustness checks. The real exchange rate was obtained as the CPI-based real effective exchange rate from the Central Bank of the Republic of Türkiye (CBRT) EVDS database. An increase in the real exchange rate indicates that the local currency, the Turkish lira, has appreciated. For economic policy uncertainty, the Global Economic Policy Uncertainty (GEPU) index developed by Baker et al. (2016) was utilized. The GEPU index is a composite measure that aggregates economic policy uncertainties from leading global economies. Economic Policy Uncertainty (EPU) is constructed for 28 countries, and global economic policy uncertainty is derived based on the data from these countries. Developed in 2016 by Baker, Bloom, and Davis, this index measures global uncertainty trends by analyzing news data from multiple countries. GEPU tends to rise significantly during global financial crises, trade wars, and pandemics, serving as an indicator of risk for the world economy.

3.3 Empirical Findings

In the study, descriptive statistics for the variables are presented in Table 1 prior to the model estimations. The table includes the following information about the variables: mean, median, maximum, minimum, standard deviation, skewness, kurtosis, and the number of observations used in the models.

Table 1. Descriptive Statistics

	LX	LY (OECD)	LY (EU)	LREER	LGEPU
Mean	4.781	4.625	4.571	4.348	5.244
Median	4.766	4.637	4.590	4.341	5.309
Maximum	5.086	4.668	4.658	4.733	6.068
Minimum	4.270	4.419	4.277	3.863	4.462
Std. Dev.	0.186	0.037	0.052	0.253	0.372
Skewness	-0.052	-2.105	-1.707	-0.107	-0.184
Kurtosis	1.858	11.131	9.523	1.559	2.049
Observations	141	141	141	141	141

It is crucial to verify the stationarity of variables before selecting the model estimation method. Stationarity tests in time series analysis help determine whether a variable's mean, variance, and covariance remain stable over time. Variables that are not stationary tend to change randomly over time, which can result in spurious regression issues when included

in analyses. In such scenarios, even if the coefficients of the model appear significant, the findings may not accurately represent reality. As a result, estimating models without performing stationarity tests can lead to unreliable and invalid conclusions. In this context, the stationarity of the variables was analyzed using the ADF (1979, 1981) and PP (1988) tests. These tests are widely employed to assess whether time series data are stationary, though they differ in their treatment of error terms. The ADF test incorporates lagged differences to address autocorrelation and assumes that the error terms exhibit constant variance (homoskedasticity). On the other hand, the PP test uses a nonparametric approach to directly account for autocorrelation and heteroskedasticity.

Table 2. Unit Root Test Results

Variables	ADF		PP	
	Intercept	Trend and Intercept	Intercept	Trend and Intercept
LX	-1.832	-6.430***	-2.460	-6.518***
LY (OECD)	-3.028*	-3.645*	-2.976**	-3.577**
LY (EU)	-2.853*	-3.453*	-3.202**	-3.991**
LREER	-1.340	-2.097	-1.275	-2.230
LGEPU	-2.240	-4.584***	-2.594	-4.488***
ΔLX	-10.122***	-10.088***	-24.420***	-24.296***
ΔLREER	-9.871***	-9.886***	-8.427***	-8.528***
ΔLGEPU	-9.846***	-9.813***	-21.410***	-22.020***

***p<0.01; **p<0.05; *p<0.1.

Examining the unit root test results in Table 2, it was found that LY (OECD) and LY (EU) are stationary at the 10% significance level. The LX, LGEPU, and LREER variables, on the other hand, are concluded to be stationary at their first differences. Since the variables were found to be both I(0) and I(1), the ARDL model was employed to explore the relationships between them. The ARDL model is widely favored for investigating long-term relationships due to its numerous advantages. Unlike traditional cointegration approaches, such as the Johansen cointegration test and the Engle-Granger method, the ARDL model offers greater flexibility and robustness. One key advantage is that while the Johansen (1991) method requires all variables to be I(1), the ARDL model accommodates both I(0) and I(1) variables. This adaptability makes it particularly useful in datasets with variables exhibiting diverse unit root characteristics. Furthermore, although the Johansen method tends to perform better with larger samples, the ARDL model produces reliable results even in small samples .The Engle-Granger (1987) method may produce biased outcomes in the presence of endogeneity problems. In contrast, the ARDL model, with its single-equation estimation approach, offers greater resilience to endogeneity issues. Moreover, it enables the simultaneous examination of short-term and long-term dynamics. These advantages make the ARDL model a highly effective tool for both academic research and practical applications. In the initial stage of ARDL model estimation, it is necessary to test for the existence of a long-term relationship among the variables. For this purpose, the bounds testing approach developed by Pesaran et al. (2011) was utilized. The bounds test is a method used within the ARDL framework to assess whether there is a long-term cointegration relationship between variables. The test evaluates the F-statistic from the estimated model against predefined critical thresholds. If the F-statistic surpasses the upper bound, a cointegration relationship is confirmed. Conversely, if it is below the lower bound, no cointegration is present. When the F-statistic falls between these two bounds, the outcome is ambiguous, necessitating additional analysis.

Table 3. ARDL Bounds Test for Cointegration Results

Models	Model 1		Model 2	
ARDL Model	ARDL (4,5,1,0)		ARDL (5,4,0,0)	
F Statistics	4.61**		4.23**	
Significance level	I(0)	I(1)	I(0)	I(1)
1%	2.01	3.1	2.01	3.1
2.50%	2.45	3.63	2.45	3.63
5%	2.87	4.16	2.87	4.16
10%	3.42	4.84	3.42	4.84

***p<0.01; **p<0.05; *p<0.1.

When examining the ARDL bounds test results in Table 3, the F-statistic values were found to be 4.61 and 4.22 in two different models where manufacturing exports serve as the dependent variable, and foreign demand, real exchange rate, and GEPU are the independent variables. In both models, since the F-statistic exceeds the 5% critical value, the presence of cointegration among the variables is confirmed.

$$\Delta y_t = \alpha\left(y_{t-1} - \beta x_{i,t-1}\right) + \sum_{j=1}^{p-1} \varphi \Delta y_{t-j} + \sum_{j=0}^{q-1} \delta \Delta x_{t-j} \quad (2)$$

Equation 2 shows the ARDL error correction model to be estimated when the bounds test indicates the presence of a long-term relationship among the variables. Here, α represents the coefficient of the error correction term, indicating the speed of adjustment to the long-term equilibrium, while β represents the coefficients of the independent variables in the long run. Additionally, the short-term dynamics are captured by the lagged differences of the dependent variable (Δy) and independent variables (Δx), which reflect the immediate effects of changes in these variables on the dependent variable.

ARDL model estimation results have been obtained, and before analyzing the model's estimation outcomes, it is

necessary to perform diagnostic tests. In this context, the model specifications presented in Appendix, Table 1, and Figures 1-2 have been examined. It was found that in both models, the errors are normally distributed, there is no autocorrelation, and the variance of the errors is homoscedastic. Additionally, the CUSUM and CUSUMQ tests indicate that the models are stable. As a result, the model outcomes can be interpreted and analyzed accordingly.

Table 4. ARDL Error Correction Model Estimation Results (Model 1)

Lon Run Equation				
Variable	Coefficient	Std. Error	t-Stat	p-value
LY (OECD)	1.386	0.110	12.585	0.000
LGEPU	0.077	0.051	1.514	0.133
LREER	-0.466	0.065	-7.180	0.000
Short Run Equation				
ECC	-0.293	0.067	-4.350	0.000
ΔLX(-1)	-0.616	0.091	-6.739	0.000
ΔLX(-2)	-0.360	0.103	-3.512	0.001
ΔLX(-3)	-0.121	0.083	-1.462	0.147
ΔLY	2.979	0.204	14.607	0.000
ΔLY(-1)	0.999	0.331	3.017	0.003
ΔLY(-2)	0.937	0.337	2.782	0.006
ΔLY(-3)	-0.429	0.290	-1.483	0.141
ΔLY(-4)	0.436	0.222	1.967	0.052
LΔGEPU	-0.005	0.019	-0.281	0.780

Table 5. ARDL Error Correction Model Estimation Results (Model 2)

Lon Run Equation				
Variable	Coefficient	Std. Error	t-Stat	p-value
LY (EU)	1.431	0.089	16.111	0.000
LGEPU	0.031	0.041	0.752	0.454
LREER	-0.441	0.053	-8.369	0.000
Short Run Equation				
ECC	-0.355	0.085	-4.165	0.000
ΔLX(-1)	-0.491	0.102	-4.817	0.000
ΔLX(-2)	-0.211	0.109	-1.932	0.056
ΔLX(-3)	-0.001	0.100	-0.014	0.989
ΔLX(-4)	0.141	0.063	2.226	0.028
ΔLY	1.795	0.146	12.278	0.000
ΔLY(-1)	0.727	0.225	3.231	0.002
ΔLY(-2)	0.469	0.231	2.031	0.045
ΔLY(-3)	-0.410	0.225	-1.824	0.071

The ARDL model results are summarized in Tables 4-5. The error correction term is statistically significant at the 1% significance level in both models. This result indicates that approximately 0.29% of the short-term imbalances are corrected in the first model, while 0.36% are corrected in the second model during the first period. In the short-term, an increase in industrial production in OECD or EU countries has a strong and positive impact on exports. This highlights the significant influence of foreign demand in export performance. However, global economic uncertainty does not have a significant effect on Türkiye's manufacturing export performance in the short-term. In the long-term, OECD industrial production (LY) has a positive effect on manufacturing exports. A 1% increase in the OECD industrial production index leads to a 1.386% increase in Türkiye's manufacturing exports. A 1% increase in industrial production in EU countries, on the other hand, results in a 1.431% increase in Türkiye's manufacturing exports. This finding indicates that foreign demand, particularly the economic activity in developed countries, has a positive impact on Türkiye's exports to these countries. The real exchange rate (LREER) shows a negative and significant effect in the long-term. A 1% increase in the real exchange rate (i.e., an appreciation of the local currency) reduces exports by 0.466% in the first model and 0.441% in the second model. This suggests that the appreciation of the local currency negatively affects the competitiveness of Türkiye's manufacturing products. On the other hand, although economic uncertainty (LGEPU) has a positive coefficient in the long-term, it is not statistically significant, indicating that global economic uncertainty does not have a substantial impact on Türkiye's export performance in the long run. The absence of a statistically significant impact of economic uncertainty (GEPU) on Türkiye's manufacturing exports, both in the short and long-term, may suggest that Türkiye's current export structure is resilient to such uncertainties. Furthermore, the diversification of Türkiye's target markets could help mitigate the influence of regional economic fluctuations on overall exports. Consequently, Türkiye's export structure and strategy may have built a more resilient framework that dampens the effects of economic uncertainties and protects against such shocks. In the long-term, Türkiye's manufacturing exports are positively influenced by increases in industrial production among its trade partners. In this context, Türkiye can focus on products with high demand in global markets, particularly in OECD and EU countries, while diversifying its exports to these regions. Additionally, enhancing international trade agreements, improving logistics infrastructure, and boosting production capacity through technological advancements will help Türkiye take greater advantage of these demand shifts. Given the significant influence of the real exchange rate on long-term exports, it is clear that competitive exchange rate

policies and structural reforms to reduce costs will play a crucial role in this process.

4. Conclusion

This paper analyzes the effects of Global Economic Policy Uncertainty (GEPU) on the export performance of Türkiye's manufacturing industry. Monthly time series data from 2013:01 to 2023:12 is used, and estimations are performed using the ARDL model. Before implementing the ARDL model, the necessary conditions for its application were checked. Specifically, all variables in the model were found to be stationary at first difference according to the ADF unit root test results, and a cointegration relationship among the variables was confirmed based on the ARDL Bound Test results. The findings of the ARDL model indicate that an increase in the value of the local currency decreases export demand for the manufacturing industry. On the other hand, increasing foreign demand positively impacts exports. These results align with expectations. Furthermore, no statistically significant relationship was found between GEPU and manufacturing industry exports. Considering that the European Union is Türkiye's primary export market, this finding is reasonable. It is assessed that Turkish exporters maintain stable and long-term trade relations; therefore, even if the GEPU level rises, it does not negatively affect Türkiye's manufacturing industry exports. This study offers several policy recommendations. Strengthening commercial and diplomatic relations, as well as enhancing international cooperation, could contribute to increased exports. Additionally, reducing exchange rate risk and expanding hedging mechanisms are expected to boost Türkiye's manufacturing industry export volume. In the medium and long-term, investments in human capital and technology are likely to create new opportunities for Türkiye's manufacturing industry exports. This study focuses on the relationship between Türkiye's manufacturing industry exports and GEPU. However, further in-depth analyses could be conducted. For instance, studies could explore examples from other countries or perform sector-specific analyses. Micro-level analyses, such as firm-level studies, could also offer valuable perspectives. In summary, there are still avenues waiting to be explored in this area.

References

Alacahan, N. D., & Akarsu, Y. (2017). The uncertainty of exchange rate in foreign trade of Turkey. Journal of Awareness, 2(3S), 331-348.

Al-Thaqeb, S. A., & Algharabali, B. G. (2019). Economic policy uncertainty: A literature review. The Journal of Economic Asymmetries, 20, e00133. https://doi.org/10.1016/j.jeca.2019.e00133

Aslan, C., & Acikgoz, S. (2021). Analysis of global economic policy uncertainty and export flows for emerging markets with panel var modeling. International Journal of Emerging Markets, 18(9), 2790-2815. https://doi.org/10.1108/IJOEM-12-2020-1570

Aslan, C., & Acikgoz, S. (2023). Are the global economic policy uncertainties blocking the export flows of emerging markets? A heterogeneous panel SVAR analysis. Economic Journal of Emerging Markets, 15(1), 87-100. https://doi.org/10.20885/ejem.vol15.iss1.art7

Assaf, R., Gupta, D., & Kumar, R. (2023). The price of war: Effect of the Russia-Ukraine war on the global financial market. The Journal of Economic Asymmetries, 28, e00328. https://doi.org/10.1016/j.jeca.2023.e00328

Baker, S. R., Bloom, N., & Davis, S. J. (2016). Measuring economic policy uncertainty. The Quarterly Journal of Economics, 131(4), 1593–1636. https://doi.org/10.1093/qje/qjw024

Baley, I., Veldkamp, L., & Waugh, M. (2020). Can global uncertainty promote international trade? Journal of International Economics, 126, 103347. https://doi.org/10.1016/j.jinteco.2020.103347

Bernanke, B. S. (1983). Irreversibility, uncertainty, and cyclical investment. The Quarterly Journal of Economics, 98(1), 85–106. https://doi.org/10.2307/1885568

Bertola, G., Guiso, L., & Pistaferri, L. (2005). Uncertainty and consumer durables adjustment. The Review of Economic Studies, 72(4), 973–1007. https://doi.org/10.1111/0034-6527.00358

Bissoondeeala, R. K., Binner, J. M., & Milas, C. (2023). Brexit and coronavirus: Financial perspectives and future prospects. The European Journal of Finance, 29(16), 1825–1834. https://doi.org/10.1080/1351847X.2023.2249961

Brogaard, J., & Detzel, A. (2015). The asset-pricing implications of government economic policy uncertainty. Management Science, 61(1), 3–18. https://doi.org/10.2139/ssrn.2105786

Chau, F., Deesomsak, R., & Wang, J. (2014). Political uncertainty and stock market volatility in the Middle East and North African (MENA) countries. Journal of International Financial Markets, Institutions and Money, 28, 1-19. https://doi.org/10.1016/j.intfin.2013.10.008

Christelis, D., Georgarakos, D., Jappelli, T., & van Rooij, M. (2020). Consumption uncertainty and precautionary saving. Review of Economics and Statistics, 102(1), 148-161. https://doi.org/10.2139/ssrn.2723056

Constantinescu, C., Mattoo, A., & Ruta, M. (2020). Policy uncertainty, trade, and global value chains: some facts, many questions. Review of Industrial Organization, 57, 285-308. https://doi.org/10.1007/s11151-020-09772-0

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Association, 74(366a), 427–431. https://doi.org/10.1080/01621459.1979.10482531

Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. Econometrica, 49(4), 1057–1072. https://doi.org/10.2307/1912517

Dixit, A. (1989). Entry and exit decisions under uncertainty. Journal of Political Economy, 97(3), 620-638. https://doi.org/10.1086/261619

Donadelli, M., Gerotto, L., Lucchetta, M., & Arzu, D. (2019). Immigration, uncertainty and macroeconomic dynamics. The World Economy, 43(2), 326-354. https://doi.org/10.1111/twec.12865

Dura, Y. C., Beşer, M. K., & Acaroğlu, H. (2017). Türkiye'nin ihracata dayalı büyümesinin ekonometrik analizi. Ege Akademik Bakış, 17(2), 295-310. https://doi.org/10.21121/eab.2017124251

Engle, R. F., & Granger, C. W. J. (1987). Co-integration and error correction: Representation, estimation, and testing. Econometrica: Journal of the Econometric Society, 55(2), 251–276. https://doi.org/10.2307/1913236

Fortin, I., Hlouskova, J., & Sögner, L. (2023). Financial and economic uncertainties and their effects on the economy. Empirica, 50, 481-521. https://doi.org/10.1007/s10663-023-09570-3

Gilchrist, S., Sim, J. W., & Zakrajšek, E. (2014). Uncertainty, financial frictions, and investment dynamics. National Bureau of Economic Research, Working Paper 20038. https://doi.org/10.3386/w20038

Giri, R., Yi, K.-M., & Yilmazkuday, H. (2021). Gains from trade: Does sectoral heterogeneity matter? Journal of International Economics, 129, 103429. https://doi.org/10.1016/j.jinteco.2021.103429

Han, L., Qi, M., & Yin, L. (2016). Macroeconomic policy uncertainty shocks on the Chinese economy: A GVAR analysis. Applied Economics, 48(51), 4907-4921. https://doi.org/10.1080/00036846.2016.1167828

Handley, K. (2014). Exporting under trade policy uncertainty: Theory and evidence. Journal of International Economics, 94(1), 50-66. https://doi.org/10.1016/j.jinteco.2014.05.005

Handley, K., & Limão, N. (2015). Trade and investment under policy uncertainty: Theory and firm evidence. American Economic Journal: Economic Policy, 7(4), 189-222. https://doi.org/10.1257/pol.20140068

Hassan, S. S., Shabi, S., & Choudhry, T. (2018). Asymmetry, uncertainty and international trade. Swansea University School of Management, Working Paper 2018-24.

Hlatshwayo, S., & Saxegaard, M. (2016). The consequences of policy uncertainty: Disconnects and dilutions in the South African real effective exchange rate-export relationship. IMF Working Papers, 16(113), 1-30. https://doi.org/10.5089/9781484383490.001

Jawadia, F., & Ftitib, Z. (2017). Uncertainty and the United States' election effect on the economy: Some thoughts and empirical illustrations. Applied Economics Letters, 24(20), 1472–1475. https://doi.org/10.1080/13504851.2017.1284983

Johansen, S. (1991). Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. Econometrica: Journal of the Econometric Society, 59(6), 1551–1580. https://doi.org/10.2307/2938278

Julio, B., & Yook, Y. (2016). Policy uncertainty, irreversibility, and cross-border flows of capital. Journal of International Economics, 103, 13-26. https://doi.org/10.1016/j.jinteco.2016.08.004

Kilic, I., & Balli, F. (2024). Measuring economic country-specific uncertainty in Türkiye. Empirical Economics, 67, 1649–1689. https://doi.org/10.1007/s00181-024-02594-z

Köse, N., & Aslan, C. (2020). The effect of real exchange rate uncertainty on Turkey's foreign trade: New evidence from SVAR model. Asia-Pacific Journal of Accounting & Economics, 30(2), 553–567. https://doi.org/10.1080/16081625.2020.1808798

Krol, R. (2018). Does uncertainty over economic policy harm trade, foreign investment, and prosperity? Mercatus Research, Mercatus Center at George Mason University, Arlington, VA. https://doi.org/10.2139/ssrn.3169563

Li, Y., & Li, J. (2021). How does China's economic policy uncertainty affect the sustainability of its net grain imports? Sustainability, 13(12), 1-21. https://doi.org/10.3390/su13126899

Matzner, A., Meyer, B., & Oberhofer, H. (2023). Trade in times of uncertainty. The World Economy, 46(9), 2564-2597. https://doi.org/10.1111/twec.13463

Mumtaz, H., & Franz, U. R. (2023). Policy uncertainty and aggregate fluctuations: Evidence from emerging and developed economies. World Bank Group Policy Research Working Paper, 10564. https://doi.org/10.1596/1813-9450-10564

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships.

Journal of Applied Econometrics, 16(3), 289–326. https://doi.org/10.1002/jae.616

Phillips, P. C. B., & Perron, P. (1988). Testing for a unit root in time series regression. Biometrika, 75(2), 335–346. https://doi.org/10.2307/2336182

Sharma, C., & Paramati, S. R. (2021). Does economic policy uncertainty dampen imports? Commodity-level evidence from India. Economic Modelling, 94, 139–149. https://doi.org/10.1016/j.econmod.2020.09.019

Şahinöz, S., & Coşar, E. E. (2018). Economic policy uncertainty and economic activity in Turkey. Applied Economics Letters, 25(21), 1517–1520. https://doi.org/10.1080/13504851.2018.1430321

Şahinöz, S., & Coşar, E. E. (2020). Quantifying uncertainty and identifying its impacts on the Turkish economy. Empirica, 47, 365–387. https://doi.org/10.1007/s10663-018-9424-8

Tam, P. S. (2018). Global trade flows and economic policy uncertainty. Applied Economics, 50(34-35), 3718-3734. https://doi.org/10.1080/00036846.2018.1436151

Yağış, O. (2024). Ekonomik politika belirsizliği ve dış ticaret ilişkisi: G-7 ülkeleri örneği. Uluslararası Beşeri Bilimler ve Eğitim Dergisi, 10(21), 75-91. https://doi.org/10.59304/ijhe.1430201

Zhao, T. (2022). Economic policy uncertainty and manufacturing value-added exports. Engineering Economics, 33(1), 103-114. https://doi.org/10.5755/j01.ee.33.1.27373

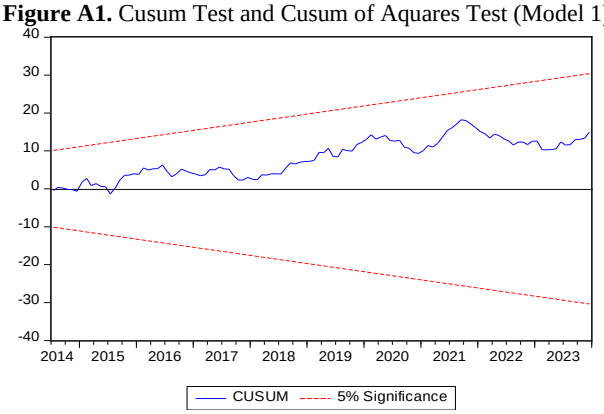
APPENDIX

Table A1. Diagnostic test results for the validity of the model

Model 1	Statistics
Jaeque-Berra Normality Test	0.071(0.965)
Breusch-Godfrey Serial Correlation LM Test	0.332(0.847)
Heteroskedasticity Test: Breusch-Pagan-Godfrey	11.805(0.544)
Model 2	Statistics
Jaeque-Berra Normality Test	0.877(0.645)
Breusch-Godfrey Serial Correlation LM Test	0.990(0.609)
Heteroskedasticity Test: Breusch-Pagan-Godfrey	8.849(0.716)

Note: P-values are given in parentheses.

Figure A1. Cusum Test and Cusum of Aquares Test (Model 1)



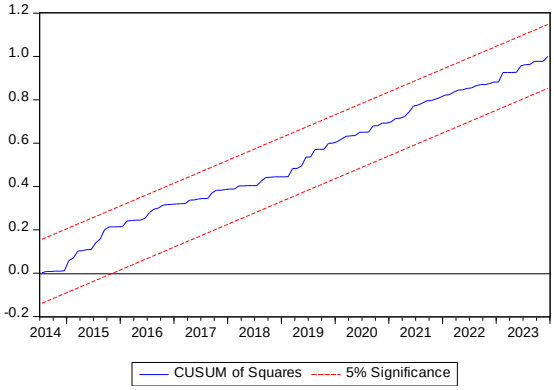
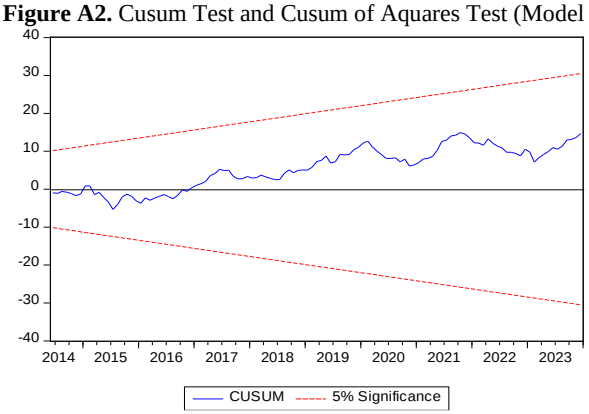
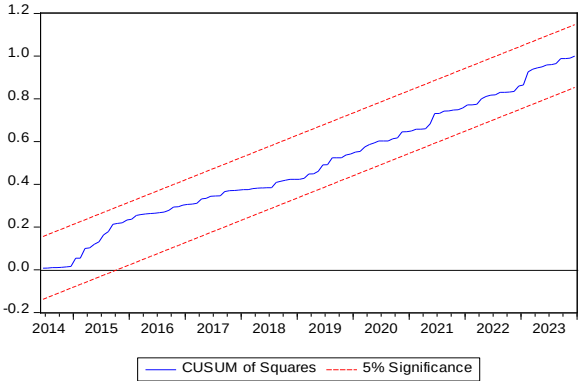


Figure A2. Cusum Test and Cusum of Aquares Test (Model 2)





INDUSTRIAL POLICY
A Scientific Journal Dedicated to Economic Development and Industrial Policy

OPEN ACCESS

Research Article

www.indpol.org

DOI: 10.61192/indpol.1575258

IndPol, 2024; 4(2): 59-74

The Effect of Natural Disaster on Regional Economic Growth: Evidence from an Earthquake in İzmir/Türkiye[1]

Aslı Dolu[a], Hüseyin İkizler[b]

[a] İzmir Bakircay University, Economics Department, ORCID: 0000-0001-6099-8704
[b] TRK Technology, ORCID: 0000-0003-4075-8206

Abstract

This study examines the economic impact of the Aegean Sea Earthquake, which struck İzmir, Türkiye, on October 30, 2020, focusing on how it affected local businesses and financial resilience. Using a combination of survey data and regression analysis, the study investigates the operational disruptions experienced by companies of varied sizes and sectors. Findings show that while large firms displayed resilience, small businesses suffered significant operational and financial setbacks, prolonging the economic recovery process. The results underscore the importance of developing robust crisis management strategies and fostering economic structures that are more resilient to both natural disasters and global crises. The study concludes with recommendations for policymakers and business leaders to enhance financial resilience to future shocks.
.

Article History
Received November 28, 2024
Revised November 29, 2024
Accepted December 2, 2024

Keywords
Natural disasters, economic resilience, earthquake, regional economic development, labor market, employment, labor demand

JEL Codes
Q54, R58, L25, J23, J24, J65

1. Introduction

Natural disasters, particularly large-scale events such as earthquakes, have extensive effects on economic development (Shabnam, 2014; Klomp, 2016; Fabian et al., 2019). These disasters can significantly slow economic growth in the short term by halting economic activities, reducing incomes, and negatively affecting businesses. However, economic development involves more than just growth; it is a long-term process aimed at enhancing social welfare, improving living standards, and strengthening infrastructure Therefore, natural disasters threaten sustainability by disrupting short-term economic growth and undermining long-term development processes. In this context, the role of businesses in the economic system becomes especially clear, as natural disasters directly affect business operations, income streams, and overall sustainability. Natural disasters and unexpected events have profound, long-lasting effects on businesses. Large-scale disasters, such as earthquakes, adversely affect business operations, revenues, and service delivery, putting long-term sustainability at risk. These situations lead to periods of uncertainty and challenge for business owners and managers, evaluating their crisis management skills (Karunasena & Amaratunga, 2014; Sarmiento et al., 2015). The Aegean Sea Earthquake, which struck the Izmir region in 2020, had a significant impact on both the local economy and

[1] This work is funded by TUBITAK (The Scientific and Technological Research Council of Turkey) under project number 121K619.

CONTACT Aslı Dolu asli.dolu@bakircay.edu.tr,

labor market. As seen in Izmir, the prolonged recovery process for small businesses caused a temporary disruption in economic development. This example proves that large-scale natural disasters have similar effects on economic development processes worldwide. Many countries, including Türkiye in the aftermath of the Izmir earthquake, have recognized the importance of learning from such crises and building more resilient economic structures.

The main challenges businesses face after an earthquake include the loss of customers, reduced income, production stoppages, and workforce losses. Small businesses were hit harder by the crisis and took longer to recover, while larger businesses showed greater resilience and actively contributed to regional development (Chang & Falit-Baiamonte, 2003; Webb, 2002). This study aims to evaluate the effects of the Aegean Sea Earthquake, which struck Izmir on October 30, 2020, on businesses and assess their preparedness for such unexpected events. The primary aim is to contribute to the development of more effective strategies for future disasters by analyzing the crisis management approaches and financial resilience of businesses of varied sizes. The analysis, considering factors such as the demographic characteristics of business owners and managers, business types, and the sectors they run in, provides a solid foundation for understanding the earthquake's impact on businesses (Corey & Deitch, 2011; Liu, Xu & Han, 2013). While the stagnation of production and trade slows overall economic development, it is notable that larger businesses tend to be more resilient to crises and recover more quickly. This highlights the importance of large companies as fundamental drivers of economic development. These businesses not only recovered swiftly but also continued to create employment and contribute to economic growth. Additionally, factors such as labor market flexibility and labor mobility played crucial roles in accelerating post-crisis recovery. In regions like Izmir, where the industry and service sectors are strong, reintegrating the workforce into the economy significantly accelerated regional development. In this context, we emphasize the need to update and prepare crisis management strategies for sustainable development. As shown in the Izmir example, developing resilient infrastructure and policies against natural disasters is critical for enhancing the sustainability of regional development. In addition, this study examines how unexpected global events such as pandemics increase the effects of earthquakes and how businesses try to cope with such crises. The study aims to evaluate the effectiveness of businesses' responses to such events by examining the differences between the pre-period and post-periods of business performance. The pandemic worsened the impact of the earthquake, highlighting that many businesses were unprepared for service interruptions. This finding underscores the need for businesses to update their crisis management strategies and be better prepared for future uncertainties. The combined effects of the pandemic and the earthquake have exposed the fragility of economic development and emphasized the importance of building more resilient economic structures for long-term, sustainable growth. In this study, we will summarize the current knowledge on the regional economic impacts of natural disasters through a literature review, present findings on labor market changes following the 2020 Aegean Sea Earthquake in the Izmir region, and evaluate the labor market's recovery process based on these findings. Additionally, we will explore how the pandemic intensified the effects of the earthquake and discuss the strategies businesses developed to respond to these crises.

2. Literature

Firms, as fundamental components of the economy, can incur significant economic losses during unexpected events such as natural disasters. In earthquake-prone regions, these disasters have serious economic consequences, often severely affecting the regional economy. However, studies examining the economic effects of earthquakes on firms are limited in the literature. Recent academic studies highlight the significant economic impact of earthquakes on small businesses, particularly in developing countries and earthquake-prone regions. These businesses often struggle with longer recovery times due to limited financial and technical resources. For example, the 2023 Turkish earthquakes caused massive damage, with the World Bank estimating a loss of over $34 billion, disproportionately affecting small and micro-enterprises that lack the infrastructure for rapid recovery (World Bank, 2023) . Small businesses in Albania similarly experienced severe disruptions following a recent earthquake, with losses in inventory, infrastructure, and customers. The United Nations Development Programme (UNDP) launched the "In Motion" recovery program to stabilize these businesses by offering support in infrastructure repair, business skill training, and reestablishing market activities. This program has shown promising results in assisting businesses to recover from both direct and indirect losses, highlighting the importance of targeted interventions in supporting small business resilience (UNDP, 2024) . Research on earthquakes and firms globally shows that businesses are highly vulnerable to such disasters (Kaushalya, Karunasena & Amaratunga, 2014; Orhan, 2016; Sarmiento et al., 2015). The literature highlights that firm size is a key factor in how quickly a business can recover from the impact of an earthquake. Larger firms, with their greater financial and technical resources, are generally able to recover

more swiftly (Chang & Falit-Baiamonte, 2003; LeSage, Pace, Lam, Campanella, & Liu, 2011; Tierney, 1997; Webb, 2002). This aligns with Schumacher and Strobl's (2011) findings, which suggest that more developed regions with stronger infrastructure tend to suffer less severe economic losses in the aftermath of a natural disaster, facilitating a quicker recovery. In contrast, small businesses, with limited resources, face greater challenges in mitigating the economic risks posed by earthquakes (Corey & Deitch, 2011; Chhibber & Laajaj, 2013). Earlier studies in developed countries have shown that over one-third of small businesses do not reopen after a disaster, and more than a quarter close within two years (Tierney & Webb, 2001). Similarly, Liu, Xu, and Han (2013) reported that following the 2008 earthquake in Wuhan, China, a sizable part of small and medium-sized businesses were unable to resume operations, with full recovery taking at least 36 months. Research in developing countries has shown comparable results: around two-thirds of small businesses in Sri Lanka (Robinson & Jarvey, 2008) and Indonesia (Pribadi, 2005) experienced lower incomes after the disaster compared to pre-event levels. A study examining sectoral differences analyzed the long-term economic recovery of 232 firms after the 1999 Adapazarı earthquake. The findings showed that firms in the finance, insurance, and real estate sectors recovered more quickly than those in other industries (Orhan, 2016). These findings are consistent with Chhibber and Laajaj's (2013) study, which emphasizes the importance of sectoral resilience, noting that sectors more aligned with the region's development strategies and financial structures tend to exhibit greater capacity for recovery. Furthermore, Schumacher and Strobl (2011) highlight that well-established sector, which often benefit from previous experiences with disasters, tend to exhibit stronger recovery mechanisms. This reinforces the importance of a sector's adaptability and its capacity to integrate crisis management practices into its operational strategies. This study will examine the effects of recent devastating earthquakes in Türkiye on local economic development to assess their socioeconomic impact. A survey focusing on the October 30, 2020, Aegean Sea Earthquake will be conducted in Izmir to evaluate the operational changes in firm activities, and these effects will be analyzed in detail.

3. Method

This study aims to understand the effects of the October 30, 2020, Aegean Sea Earthquake on companies running in Izmir and to analyze how such natural disasters influence business activities. A comprehensive survey and multivariate regression analysis were conducted to assess the short- and long-term impacts of the earthquake on company operations.

3.1 Survey Design and Implementation Process

The survey in this study evaluates changes in business activity after the earthquake and assesses the expected impact of future earthquakes by focusing on the sectoral distribution, size, and other descriptive statistics of the companies. The survey includes three sections and a total of thirty-three questions. The first section gathers descriptive information about the sector and size of the companies. The second section has questions about the extent to which activities changed after the earthquake. The third section features questions that predict how future earthquakes may affect the companies' operations.

We sent the online survey to all companies running in Izmir with the support of the Izmir Development Agency. However, due to insufficient responses from the online surveys, we also conducted face-to-face surveys with the agency's support. In total, 128 companies took part in the survey, and the analysis collected the obtained data. The study aimed to provide reliable results with a 5 percent margin of error.

In this study, the sample selection was based on the sectoral distribution of companies registered with the İzmir Chamber of Commerce. The table below compares the sectoral distribution of firms registered with the İzmir Chamber of Commerce to that of the survey sample:

Table 1: Sectoral Distribution Comparison of İzmir Chamber of Commerce Registered Companies and Survey Sample

Sector	Number of Companies Registered with the İzmir Chamber of Commerce	Percentage of Total (%)	Number of Firms in the Survey Sample	Sample Percentage (%)
Trade	30	46.5	65	50.8
Services	15	23.2	32	25
Manufacturing /Production	10	15.5	20	15.6
Agriculture-Livestock	5	7.8	7	5.5
Tourism	4,521	7	4	3.1
Total	64,521	100	128	100

The table shows that the survey sample largely reflects the sectoral distribution of companies registered with the İzmir Chamber of Commerce. Particularly in the trade and services sectors, the sample percentages align closely with the population percentages. Given that the trade sector constitutes the largest share in the Chamber's records, it is also predominantly represented in the survey. This alignment enhances the representativeness of the survey results.

3.2 Data Collection and Analysis Methods

The analysis of this study employed the multivariate regression model. This models the relationship between multiple dependent variables and one or more independent variables, effectively deriving meaningful results from complex data sets.

In our study, the multivariate regression examines 4 dependent variables (Y_1,Y_2,Y_3 and Y_4) and their relationships with a set of 9 independent variables (X_1,X_2, …, X_9). The equations can be written as:

$$Y_1 = \beta_{10} + \beta_{11}X_1 + \beta_{12}X_2 + \cdots + \beta_{19}X_9 + \epsilon_1$$
$$Y_2 = \beta_{20} + \beta_{21}X_1 + \beta_{22}X_2 + \cdots + \beta_{29}X_9 + \epsilon_2$$

And so on, for Y_3 and Y_4. Each dependent variable is modeled as a linear combination of the independent variables, with distinct coefficients for each dependent variable. In this study, dependent variables included the number of customers, income status, production level, number of employees, and demand for intermediate goods seen in businesses after the earthquake. Researchers associated these dependent variables with independent variables such as the age, gender, and education level of the company owner, the owner's sector knowledge, the age of the company and its building, the number of employees, employee experience, and the ability to work remotely. The regression analyses revealed that the significance tests for all models yielded results at a significance level of 1 percent. Additionally, the error terms related to the periodic model results showed periodic relationships for all models. This finding shows that it is proper to evaluate different periods within the same model. Detailed reports and estimates about the analysis results appear in the appendix.

4. Results

4.1 Number of Customers of Businesses

The analysis shows that sectoral effects significantly influenced changes in the number of customers for companies after the earthquake. The tourism sector, being the most vulnerable, experienced the largest decline in customer numbers. Businesses in this sector, including hotels, travel agencies, and tour operators, saw a sharp drop in visitors due to the immediate disruptions caused by the earthquake. The combination of damaged infrastructure canceled travel plans, and a loss of consumer confidence in the safety of the region resulted in a significant reduction in customer numbers. The tourism sector's reliance on physical presence, along with the global perception of the region as being affected by natural disasters, compounded the challenges of recovery. Additionally, an increase in the age of the company positively affects customer retention due to earthquake effects. This finding shows that more established and long-standing companies tend to be more resilient during crises and are better at minimizing customer loss.

Table 2. Periodic Impact of Earthquake on Change in Number of Customers

Equation	Obs	Parms	RMSE	"R-sq"	F	P>F
number~r_1_2	128	9	1.432609	0.7277	35.33958	0.0000
num~r_1_week	128	9	1.157774	0.8946	112.2755	0.0000
nu~r_1_month	128	9	.9054094	0.9446	225.4637	0.0000
nu~r_6_month	128	9	.8252854	0.9570	294.4518	0.0000

	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
number_of_customer_1_2						
age	-.0469935	.1131809	-0.42	0.679	-.271103	.1771159
gender	-.420726	.282919	-1.49	0.140	-.9809338	.1394818
sector	.5299644	.2347142	2.26	0.026	.0652068	.994722
firm_age	.3139153	.2392663	1.31	0.192	-.1598559	.7876864
building_age	.0552484	.0790352	0.70	0.486	-.1012492	.211746
education	.3999955	.2176161	1.84	0.069	-.030906	.8308971
number_of_workers	.0926077	.4260752	0.22	0.828	-.7510639	.9362792
experience_of_the_workers	.1144028	.1916328	0.60	0.552	-.2650494	.4938549
remote	-.1959018	.2620463	-0.75	0.456	-.7147796	.322976
number_of_customer_1_week						
age	.0261661	.091468	0.29	0.775	-.1549497	.2072819
gender	-.0548676	.2286432	-0.24	0.811	-.5076039	.3978687
sector	1.052026	.1896861	5.55	0.000	.6764283	1.427623
firm_age	.3733581	.1933649	1.93	0.056	-.0095238	.75624
building_age	.0599173	.0638729	0.94	0.350	-.0665575	.186392
education	.017893	.1758681	0.10	0.919	-.3303434	.3661294
number_of_workers	.4393613	.344336	1.28	0.204	-.2424584	1.121181
experience_of_the_workers	.1081395	.1548696	0.70	0.486	-.1985177	.4147967
remote	.2673486	.2117747	1.26	0.209	-.1519866	.6866837

number_of_customer_1_month						
age	.0331724	.0715304	0.46	0.644	-.1084648	.1748097
gender	.1113867	.1788049	0.62	0.535	-.2426649	.4654383
sector	1.395552	.1483395	9.41	0.000	1.101825	1.689279
firm_age	.2580458	.1512164	1.71	0.091	-.0413778	.5574694
building_age	.0112196	.0499503	0.22	0.823	-.087687	.1101261
education	-.0951805	.1375335	-0.69	0.490	-.3675105	.1771495
number_of_workers	.4353862	.2692798	1.62	0.109	-.0978146	.968587
experience_of_the_workers	.1710075	.121112	1.41	0.161	-.0688065	.4108214
remote	.2094193	.1656134	1.26	0.209	-.1185117	.5373503
number_of_customer_6_month						
age	-.0264369	.0652003	-0.41	0.686	-.15554	.1026662
gender	.1057784	.1629816	0.65	0.518	-.2169415	.4284983
sector	1.441496	.1352122	10.66	0.000	1.173763	1.70923
firm_age	.3705793	.1378346	2.69	0.008	.0976531	.6435056
building_age	.0231718	.0455299	0.51	0.612	-.0669821	.1133256
education	-.0906897	.1253625	-0.72	0.471	-.3389199	.1575405
number_of_workers	.592587	.2454499	2.41	0.017	.1065717	1.078602
experience_of_the_workers	.1454048	.1103943	1.32	0.190	-.0731868	.3639965
remote	.1709118	.1509575	1.13	0.260	-.1279991	.4698226

The research findings highlight that factors such as company experience and customer loyalty play a critical role in maintaining or regaining customer numbers after natural disasters. In sectors that directly interact with customers, like the service industry, the experience and reputation associated with a company's age enhance customer loyalty and result in less loss during crises. Consequently, developing and implementing crisis management strategies can help companies increase their resilience against unexpected events such as natural disasters. Factors such as experience, sectoral knowledge, and customer loyalty are crucial in reducing the impact of crises on companies, and effectively managing these factors can shape their long-term success.

4.2 Income Status of Businesses

The analysis revealed that sectoral effects played a decisive role in influencing the changes in company income during the period following the earthquake. Companies operating in certain sectors, such as manufacturing and services, experienced different levels of impact due to their distinct operational structures, supply chains, and customer bases. For instance, businesses in sectors that rely heavily on physical infrastructure or face-to-face interactions were more vulnerable to the immediate disruptions caused by the earthquake, while those in digital or service-based sectors showed a more rapid recovery. The extent of sector-specific resilience was further shaped by factors like the flexibility of business models, the availability of alternative work arrangements, and the ability to quickly adapt to new market conditions. Additionally, the increase in company age positively affected the effects of the earthquake on income. This finding shows that well-established and long-term companies tend to be more resilient during crises and excel at minimizing income loss. The research results reveal that a company's experience, reputation, and financial resilience play vital roles in supporting or increasing income after natural disasters. In sectors with direct customer interaction, such as the service industry, a company's age and experience enable a faster income recovery. As a company ages, strengthened customer loyalty and a solid market position allow it to manage financial losses more effectively during crises.

Table 3. Periodic Effect of Earthquake on Change in Income

Equation	Obs	Parms	RMSE	"R-sq"	F	P>F
revenue_1_2	128	9	1.374173	0.7686	43.91169	0.0000
revenue_1_~k	128	9	1.095155	0.9066	128.3344	0.0000
revenue_1_~h	128	9	.9015295	0.9451	227.6593	0.0000
revenue_6_~h	128	9	.777944	0.9619	333.9559	0.0000

	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
revenue_1_2						
age	-.0330422	.1085642	-0.30	0.761	-.2480102	.1819259
gender	-.5373346	.2713788	-1.98	0.050	-1.074692	.0000225
sector	.4073677	.2251403	1.81	0.073	-.0384325	.853168
firm_age	.4425118	.2295067	1.93	0.056	-.0119344	.8969579
building_age	.0509142	.0758114	0.67	0.503	-.0991999	.2010283
education	.3977662	.2087395	1.91	0.059	-.015559	.8110913

number_of_workers	.7267221	.4086957	1.78	0.078	-.0825362	1.53598
experience_of_the_workers	.1377753	.1838162	0.75	0.455	-.2261991	.5017497
remote	.1000426	.2513575	0.40	0.691	-.3976702	.5977555
revenue_1_week						
age	-.0102247	.0865209	-0.12	0.906	-.1815447	.1610952
gender	-.1918211	.2162768	-0.89	0.377	-.6200707	.2364285
sector	1.099307	.1794268	6.13	0.000	.7440237	1.45459
firm_age	.3910651	.1829066	2.14	0.035	.0288918	.7532385
building_age	.0584439	.0604183	0.97	0.335	-.0611903	.1780781
education	-.1097137	.1663561	-0.66	0.511	-.4391155	.219688
number_of_workers	.6295249	.3257123	1.93	0.056	-.015418	1.274468
experience_of_the_workers	.1618011	.1464933	1.10	0.272	-.1282703	.4518724
remote	.4445789	.2003207	2.22	0.028	.0479239	.8412339
revenue_1_month						
age	.0064751	.0712238	0.09	0.928	-.1345552	.1475055
gender	.0017205	.1780387	0.01	0.992	-.3508139	.3542549
sector	1.412755	.1477038	9.56	0.000	1.120287	1.705224
firm_age	.26218	.1505684	1.74	0.084	-.0359606	.5603205
building_age	.0011083	.0497362	0.02	0.982	-.0973744	.099591
education	-.1161618	.1369441	-0.85	0.398	-.3873248	.1550012
number_of_workers	.5528742	.2681258	2.06	0.041	.0219583	1.08379
experience_of_the_workers	.2038228	.1205931	1.69	0.094	-.0349634	.4426091
remote	.3094426	.1649037	1.88	0.063	-.0170832	.6359683
revenue_6_month						
age	-.0304561	.0614602	-0.50	0.621	-.1521534	.0912412
gender	.0530364	.1536324	0.35	0.731	-.2511711	.3572439
sector	1.460722	.127456	11.46	0.000	1.208347	1.713098
firm_age	.3548607	.1299279	2.73	0.007	.0975905	.6121309
building_age	.0292387	.0429182	0.68	0.497	-.0557436	.114221
education	-.1144665	.1181712	-0.97	0.335	-.3484573	.1195243
number_of_workers	.6510338	.23137	2.81	0.006	.192898	1.10917
experience_of_the_workers	.1534974	.1040617	1.48	0.143	-.0525551	.3595498
remote	.2232356	.142298	1.57	0.119	-.0585287	.5049998

Moreover, a high number of employees positively affects company income after the earthquake. More employees increase the company's operational ability, enabling quicker and more effective responses in times of crisis. This ability helps keep uninterrupted productivity and customer service, minimizing revenue loss. Large-scale companies can use their employees' skills and participation in crisis management processes to sustain their activities. Interestingly, the education of the company owner significantly affects revenue changes within 1-2 days after the earthquake. However, this effect diminishes over time. The findings reveal that highly educated owners can minimize revenue loss by making quick and effective decisions during crises. On the other hand, the decline of this effect in the long term suggests that crisis management relies on more than just owner education; other factors also play a role. These include company age, experience, reputation, and financial resilience. Well-established companies can recover their revenues more quickly due to their industry reputation and customer loyalty. The research findings emphasize the importance of sustainable strategies and operational resilience for long-term success, as well as the ability to cope with short-term effects during crisis periods. Although owner education initially influences income changes, over time, the firm's overall resilience and crisis management strategies become more significant.

4.3 Production Status of Enterprises

The analysis shows that sectoral effects played a key role in changing the production levels of firms after the earthquake. Additionally, increasing the age of the firm positively affects changes in production levels due to earthquake effects. This finding reveals that well-established firms with long operating histories tend to be more resilient during crises and excel at minimizing production losses. The research results show that a firm's experience, production process efficiency, and sectoral knowledge are critical for keeping or increasing production levels during crises such as natural disasters. The experience and operational efficiencies of firms in the production sector, gained through age, play a significant role in minimizing production fluctuations during crisis periods.

Table 4. Periodic Effect of Earthquake on Change in Production

Equation	Obs	Parms	RMSE	"R-sq"	F	P>F
production~2	128	9	1.445103	0.7894	49.56076	0.0000
production~k	128	9	1.127573	0.9067	128.4391	0.0000
prod~1_month	128	9	.9645104	0.9384	201.5279	0.0000
prod~6_month	128	9	.8676135	0.9527	266.3441	0.0000

	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
production_1_2						
age	.0259572	.114168	0.23	0.821	-.2001068	.2520212
gender	-.5744241	.2853864	-2.01	0.046	-1.139518	-.0093305
sector	1.118506	.2367612	4.72	0.000	.6496956	1.587317
firm_age	.3336607	.241353	1.38	0.169	-.1442424	.8115638
building_age	.0486637	.0797245	0.61	0.543	-.1091988	.2065262
education	.2645846	.219514	1.21	0.230	-.1700749	.6992442
number_of_workers	-.1337238	.4297912	-0.31	0.756	-.9847533	.7173057
experience_of_the_workers	-.1513595	.1933041	-0.78	0.435	-.534121	.231402
remote	-.0371753	.2643317	-0.14	0.888	-.5605784	.4862278
production_1_week						
age	.0225798	.089082	0.25	0.800	-.1538115	.1989711
gender	-.1454126	.2226789	-0.65	0.515	-.5863391	.2955139
sector	1.22447	.1847381	6.63	0.000	.8586699	1.59027
firm_age	.3026391	.1883209	1.61	0.111	-.0702551	.6755333
building_age	.064619	.0622068	1.04	0.301	-.0585566	.1877946
education	-.1246038	.1712805	-0.73	0.468	-.4637563	.2145487
number_of_workers	.5352061	.3353539	1.60	0.113	-.1288281	1.19924
experience_of_the_workers	.1441285	.1508297	0.96	0.341	-.1545294	.4427864
remote	.3557529	.2062505	1.72	0.087	-.0526437	.7641494
production_1_month						
age	.0410909	.0761995	0.54	0.591	-.1097918	.1919736
gender	.01995	.1904765	0.10	0.917	-.3572125	.3971125
sector	1.489847	.1580224	9.43	0.000	1.176947	1.802747
firm_age	.2457421	.1610871	1.53	0.130	-.0732265	.5647107
building_age	.0212982	.0532108	0.40	0.690	-.0840646	.1266609
education	-.2157063	.146511	-1.47	0.144	-.5058127	.0744002
number_of_workers	.5855967	.2868571	2.04	0.043	.0175909	1.153602
experience_of_the_workers	.1466607	.1290177	1.14	0.258	-.1088073	.4021286
remote	.3570239	.1764239	2.02	0.045	.0076871	.7063608
production_6_month						
age	.0085841	.0685444	0.13	0.901	-.1271406	.1443088
gender	-.0653578	.1713408	-0.38	0.704	-.4046297	.2739141
sector	1.489263	.1421471	10.48	0.000	1.207797	1.770728
firm_age	.3384627	.144904	2.34	0.021	.0515384	.6253871
building_age	.0307322	.0478651	0.64	0.522	-.0640456	.1255099
education	-.1525068	.1317922	-1.16	0.250	-.4134685	.1084549
number_of_workers	.6388152	.2580388	2.48	0.015	.1278725	1.149758
experience_of_the_workers	.1327016	.1160563	1.14	0.255	-.0971014	.3625047
remote	.2546455	.1586999	1.60	0.111	-.0595962	.5688872

As a result, effectively implementing crisis management strategies can help businesses enhance their resilience against unexpected events like natural disasters. The combination of experience, sectoral knowledge, and operational efficiency is crucial for reducing the impact of crises on businesses. Thoughtful management of these factors plays a significant role in shaping the long-term production success of companies.

4.4 Number of Employees of Businesses

According to the analysis, only sectoral factors decisively influenced changes in the number of employees at the company. While the company's suitability for remote work positively affected employee numbers in the first week after the earthquake, this effect did not continue significantly in later periods. The findings show that the sector in which the company runs plays a critical role in figuring out changes in the number of employees. Specifically, labor demand in the sector during crises and the company's position within that sector are key factors influencing employee numbers.

Table 5. Periodic Effect of Earthquake on Change in Number of Employees

Equation	Obs	Parms	RMSE	"R-sq"	F	P>F
number~s_1_2	128	9	1.644386	0.7869	48.82565	0.0000
num~s_1_week	128	9	1.002395	0.9366	195.2228	0.0000
nu~s_1_month	128	9	.913928	0.9486	244.1813	0.0000
nu~s_6_month	128	9	.9156259	0.9488	245.083	0.0000

	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
number_of_workers_1_2						
age	-.0441755	.129912	-0.34	0.734	-.3014142	.2130632
gender	-.0786638	.3247418	-0.24	0.809	-.7216851	.5643575
sector	1.26495	.2694112	4.70	0.000	.7314885	1.798411
firm_age	.0459296	.2746362	0.17	0.867	-.4978775	.5897367
building_age	.1933029	.0907187	2.13	0.035	.0136708	.3729349
education	-.0925998	.2497854	-0.37	0.712	-.5871999	.4020003
number_of_workers	.0822226	.4890604	0.17	0.867	-.8861659	1.050611
experience_of_the_workers	.0147458	.2199612	0.07	0.947	-.4207994	.450291
remote	.2001257	.3007836	0.67	0.507	-.3954559	.7957073
number_of_workers_1_week						
age	.0144255	.0791925	0.18	0.856	-.1423836	.1712345
gender	.0664445	.1979581	0.34	0.738	-.3255323	.4584212
sector	1.556303	.1642292	9.48	0.000	1.231113	1.881494
firm_age	.2722626	.1674143	1.63	0.107	-.0592345	.6037597
building_age	.0809517	.0553008	1.46	0.146	-.0285495	.1904529
education	-.2743165	.1522657	-1.80	0.074	-.5758178	.0271847
number_of_workers	.5440344	.2981243	1.82	0.071	-.0462815	1.13435
experience_of_the_workers	.065993	.1340853	0.49	0.624	-.1995092	.3314952
remote	.3797442	.1833535	2.07	0.041	.016686	.7428023
number_of_workers_1_month						
age	.0236295	.0722034	0.33	0.744	-.1193404	.1665993
gender	.1765141	.1804872	0.98	0.330	-.1808686	.5338968
sector	1.423118	.1497352	9.50	0.000	1.126628	1.719609
firm_age	.3433939	.1526392	2.25	0.026	.0411531	.6456347
building_age	.0913016	.0504202	1.81	0.073	-.0085355	.1911387
education	-.1422627	.1388274	-1.02	0.308	-.4171549	.1326295
number_of_workers	.5968775	.2718133	2.20	0.030	.0586601	1.135095
experience_of_the_workers	.0582278	.1222515	0.48	0.635	-.1838424	.3002981
remote	.2597829	.1671716	1.55	0.123	-.0712335	.5907993
number_of_workers_6_month						
age	.0203207	.0723375	0.28	0.779	-.1229147	.1635562
gender	.1647792	.1808225	0.91	0.364	-.1932675	.5228258
sector	1.404356	.1500133	9.36	0.000	1.107315	1.701397
firm_age	.3651045	.1529227	2.39	0.019	.0623022	.6679068
building_age	.0885114	.0505139	1.75	0.082	-.0115112	.188534
education	-.118684	.1390854	-0.85	0.395	-.3940869	.1567189
number_of_workers	.6511886	.2723183	2.39	0.018	.1119712	1.190406
experience_of_the_workers	.0605748	.1224787	0.49	0.622	-.1819452	.3030948
remote	.2320231	.1674821	1.39	0.169	-.0996082	.5636544

The limited effectiveness of remote work only in the early days of the crisis highlights the need for the company to review its crisis management strategies. Continuously and effectively offering remote work options during crisis management can help companies mitigate the impact of crises and keep stable employee numbers. As a result, sectoral dynamics and the company's crisis management strategies significantly influence changes in employee numbers. Careful management of these factors is crucial for shaping the company's long-term success.

4.5 Intermediate Goods Demand of Businesses

According to the analysis, changes in the demand for intermediate goods at the company depend on factors, including the sector, the age of the company, the age of the business building, the number of employees, and the ability to work remotely. In particular, the general demand dynamics and competitive conditions of the sector play a determining role in the demand for intermediate goods. As the company's age increases, its experience and reputation can positively influence this demand.

Table 6. Periodic Effect of Earthquake on Intermediate Goods Demand Change

Equation	Obs	Parms	RMSE	"R-sq"	F	P>F
input_dema~2	128	9	1.037005	0.9220	156.3303	0.0000
input_dema~k	128	9	.8127693	0.9563	289.0311	0.0000
inpu~1_month	128	9	.6948112	0.9699	426.6075	0.0000
inpu~6_month	128	9	.6684116	0.9726	469.7462	0.0000

	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
input_demand_1_2						
age	-.0567499	.0819269	-0.69	0.490	-.2189733	.1054735
gender	.067769	.2047931	0.33	0.741	-.3377419	.4732798
sector	1.399645	.1698997	8.24	0.000	1.063227	1.736064
firm_age	.0178293	.1731948	0.10	0.918	-.3251137	.3607723
building_age	.1770138	.0572103	3.09	0.002	.0637318	.2902958
education	-.1249885	.1575231	-0.79	0.429	-.4369	.1869229
number_of_workers	.2388662	.3084179	0.77	0.440	-.3718321	.8495645
experience_of_the_workers	.1512931	.1387149	1.09	0.278	-.1233763	.4259626
remote	-.2799067	.1896843	-1.48	0.143	-.6555005	.095687
input_demand_1_week						
age	-.0202936	.0642115	-0.32	0.753	-.1474387	.1068516
gender	.1440406	.1605099	0.90	0.371	-.173785	.4618661
sector	1.382719	.1331616	10.38	0.000	1.119046	1.646393
firm_age	.1798651	.1357442	1.33	0.188	-.0889219	.4486522
building_age	.1309019	.0448394	2.92	0.004	.0421153	.2196885
education	-.0844126	.1234612	-0.68	0.495	-.3288781	.160053
number_of_workers	.6014915	.2417275	2.49	0.014	.122847	1.080136
experience_of_the_workers	.1149854	.10872	1.06	0.292	-.1002911	.330262
remote	.1503794	.1486681	1.01	0.314	-.1439982	.444757
input_demand_1_month						
age	.0133138	.0548924	0.24	0.809	-.0953787	.1220062
gender	.2259514	.1372149	1.65	0.102	-.0457478	.4976506
sector	1.412507	.1138357	12.41	0.000	1.187101	1.637913
firm_age	.2697033	.1160435	2.32	0.022	.0399256	.499481
building_age	.0736182	.0383319	1.92	0.057	-.0022827	.1495191
education	.0032728	.1055432	0.03	0.975	-.2057132	.2122588
number_of_workers	.5576929	.2066453	2.70	0.008	.1485145	.9668712
experience_of_the_workers	.0917062	.0929414	0.99	0.326	-.092327	.2757395
remote	.1766504	.1270917	1.39	0.167	-.0750039	.4283047
input_demand_6_month						
age	.0163615	.0528067	0.31	0.757	-.0882012	.1209241
gender	.2311204	.1320014	1.75	0.083	-.0302555	.4924963
sector	1.370936	.1095105	12.52	0.000	1.154094	1.587777
firm_age	.3247534	.1116344	2.91	0.004	.1037062	.5458006
building_age	.0776254	.0368754	2.11	0.037	.0046083	.1506424
education	.0334398	.101533	0.33	0.742	-.1676058	.2344853
number_of_workers	.5901395	.1987937	2.97	0.004	.196508	.9837709
experience_of_the_workers	.0787349	.08941	0.88	0.380	-.0983059	.2557758
remote	.1368494	.1222628	1.12	0.265	-.1052432	.378942

Interestingly, the analysis shows that the age of the company's building positively affects the demand for intermediate goods. This finding shows that an older building or one with a long history contributes to more reliable and sustainable production processes, enhancing the supply of intermediate goods. Additionally, the number of employees and the ability to work remotely significantly affect the demand for intermediate goods. Maintaining flexibility in employee numbers and enabling remote work during crisis periods can positively influence the company's operational continuity and demand management.

5. Conclusion and Recommendations

We analyzed the economic impact of the Aegean Sea Earthquake, which struck İzmir, Türkiye, on October 30, 2020, by exploring its effects on local businesses, their recovery processes, and overall financial resilience in the region. The findings reveal that businesses are still insufficiently prepared for natural disasters like earthquakes. Additionally, recent unexpected events, such as pandemics, have intensified their impacts on businesses and underscored the urgent need for effective emergency management

strategies. These crises yield varying results based on the experience and knowledge of the companies involved. The research shows that experienced and well-established companies exhibit greater resilience during crises due to their institutional knowledge and effective crisis management strategies. These companies succeed in minimizing customer loss, protecting their income, ensuring production continuity, and managing their workforce effectively. Therefore, crisis management processes play a critical role in figuring out the long-term success of businesses. To enhance preparedness against crises, business owners and managers should take several initiative-taking steps. First, they should regularly attend crisis management training to improve their ability to respond effectively to crises and bolster their businesses' ability to cope. Additionally, companies need to develop alternative business continuity strategies to keep operations and ensure consistent customer service. Diversifying suppliers and accessing different supply sources can also minimize disruptions in the supply chain. Public-private partnerships offer another avenue for effective crisis preparedness. Collaborating with local governments and other organizations enables businesses to create joint crisis plans and respond in a coordinated manner. Furthermore, developing sustainability plans and using information and communication technologies can enhance resilience during crises. State-supported crisis management training and consultancy services can equip business owners and managers with the skills to make effective decisions during crises and ensure operational continuity. Organizing training on crisis communication and post-crisis recovery strategies can also prepare businesses for these processes. This policy proposal can succeed through cooperation between the state and the private sector, empowering businesses to respond more effectively to crises and sustain their long-term success. Ultimately, businesses must prepare for and respond effectively to natural disasters and crises. This study provides a foundation for guiding businesses in this regard and developing crisis management strategies. However, each business needs to adapt its preparedness plans and strategies to its specific circumstances. Future research that delves deeper into diverse types of crises and how businesses across different industries respond could further enhance crisis management strategies. The limitations of this study should be acknowledged. While the findings provide valuable insights into the economic impact of natural disasters on local businesses, the scope of the research was confined to businesses in İzmir, Türkiye. Therefore, the results may not be universally applicable to other regions or industries without further investigation. Additionally, the study primarily relied on survey data, which may have been influenced by response biases or limitations in sample representation. Future research could expand the sample size and include diverse geographical locations and industries to further validate the findings and improve the generalizability of the results. In terms of future academic implications, this study highlights the need for further research on the intersection of crisis management and business resilience, particularly in the context of natural disasters and other unexpected global events. Future studies could explore the role of technology and innovation in crisis preparedness, as well as the impact of digital transformation on business recovery. Overall, the findings of this study are largely consistent with the existing literature, supporting the robustness of the results and demonstrating their alignment with previously established patterns and theories. This consistency not only reinforces the validity of the current analysis but also highlights its contribution to the broader understanding of the topic by offering additional insights and empirical evidence within the context studied.

References

Abadie, A., & Gardeazabal, J. (2003). The Economic Costs of Conflict: A Case Study of the Basque Country. American Economic Review, 93(1), 113-132.

Abadie, A., Diamond, A., & Hainmueller, J. (2010). Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program. Journal of the American Statistical Association, 105(490), 493-505.

Abadie, A., Diamond, A., & Hainmueller, J. (2015). Comparative Effectiveness of Synthetic Control Methods for Comparative Case Studies: A Monte Carlo Study. Journal of the American Statistical Association, 110(512), 650-664.

Athey, S., & Imbens, G. W. (2017). The State of Applied Econometrics: Causal Effects. Journal of Economic Perspectives, 31(2), 3-32.

Barone, G., & Mocetti, S. (2014). The Effect of Immigration on the Italian Labour Market. The Economic Journal, 124(576), 154-179.

Chang, S. E., & Falit-Baiamonte, A. (2003). Disaster vulnerability of businesses in the 2001 Nisqually earthquake. Environmental Hazards, 5(2), 59-71.

Chhibber, A., & Laajaj, R. (2013). The interlinkages between natural disasters and economic development. *The economic impacts of natural disasters*, 28-56.

Corey, C. M., & Deitch, E. A. (2011). Factors affecting business recovery immediately after Hurricane Katrina. Journal of Contingencies and Crisis Management, 19(3), 169-181.

Fabian, M., Lessmann, C., & Sofke, T. (2019). Natural disasters and regional development–the case of earthquakes. Environment and Development Economics, 24(5), 479-505.

Kaushalya, S., Karunasena, G., & Amaratunga, D. (2014). Capacity building for post-disaster construction and demolition waste management: A case of Sri Lanka. Disaster Prevention and Management, 23(4), 420-437.

Klomp, J. (2016). Economic development and natural disasters: A satellite data analysis. *Global Environmental Change*, *36*, 67-88.

Liu, A., Xu, J., & Han, L. (2013). Business recovery after the 2008 Wenchuan earthquake. Disasters, 37(2), 226-249.

Orhan, E. (2016). The economic recovery process after the 1999 Adapazarı earthquake. Journal of Economic Studies, 43(1), 15-29.

Robinson, J., & Jarvey, C. (2008). Impact of disasters on small businesses in Sri Lanka. International Journal of Disaster Risk Reduction, 27(1), 99-108.

Sarmiento, J. P., et al. (2015). Disaster risk management and business education: The case of a Colombian business school. Risk Management, 17(3), 155-176.

Schumacher, I., & Strobl, E. (2011). Economic development and losses due to natural disasters: The role of hazard exposure. *Ecological Economics*, *72*, 97-105.

Shabnam, N. (2014). Natural disasters and economic growth: A review. *International Journal of Disaster Risk Science*, *5*, 157-163.

Tierney, K. (1997). Business vulnerability to disaster-related lifeline disruption. Disasters, 21(1), 10-27.

Tierney, K., & Webb, G. R. (2001). Business vulnerability to earthquakes and other disasters. Risk Management, 3(2), 61-72.

UNDP (2020, February 20). Supporting small businesses in earthquake recovery. https://www.undp.org/stories/supporting-small-businesses-earthquake-recovery

Worldbank (2024, February 6). From earthquake devastation to resilient revival in Türkiye. https://www.worldbank.org/en/news/feature/2024/02/05/from-earthquake-devastation-to-resilient-revival-in-turkiye

Webb, G. R. (2002). Coordination: Disaster recovery and the role of community organizations. Public Entity Risk Institute.

APPENDIX

SURVEY FORM

DATE:

This survey form was prepared for a research conducted on behalf of TÜBİTAK at the Department of Economics, Faculty of Economics and Administrative Sciences, Bakırçay University. The study aims to examine the extent to which the earthquake affected the performance of businesses and to determine the changes in the labor market, which is the final result of business performance. This scientific research has no administrative or political aspect.
Please do not write your name, surname or anything indicating your identity on the survey form.
There are 28 questions in this survey. Try to answer the questions with as many single options as possible.
In cases where you can give more than one answer, please do not exceed 3 options. Answering the questions completely, realistically and sincerely will contribute to the achievement of the purpose of this research.
Answer the questions by placing an X in the spaces in parentheses. Example: (X)
If the sections allocated for the answer are not sufficient and/or if there are no answers suitable for you, you can also use the empty sections of the survey form for the answer.
Thank you in advance for your valuable help and contributions with your answers to the questions.

Best regards

Assistant Professor Aslı DOLU — Project Executive

Dr. Hüseyin İKİZLER — Researcher

QUESTIONS

Part-1 Descriptive Statistics
1. What is your age?
l.( ) 15-20 between ages 2.( ) 21-30 between ages 3.( ) 31-40 between ages 4.( ) 41-50 between ages
5.( ) 51-60 between ages 6.( ) 60-65 between ages 7.( ) 65 Ages and above
2. What is the gender of the business owner/partners? (If there are partners, more than one mark can be made.)
1.( ) Female 2.( ) Male 3.( ) I Don't Want To Specify
3. Which industry do you think the business serves the most?
1.( ) Agriculture-Animal Husbandry 2.( ) Trade 3.( ) Services
4.( ) Manufacturing-Production 5.( ) Tourism 6.( ) Transportation
4. The first two numbers of your business's Nace Code, which indicates your field of activity in the Izmir Chamber of Commerce membership information system? (01-99)
.....
5. What is the status of your business?
1.( ) Individual Company 2.( ) Limited Company 3.( ) Joint Stock Company 4.( ) Collective Company
6. How many years has the business been in business?
1.( ) Less than 3 years 2.( ) 3-5 years 3.( ) More than 5 years
7. Graduation of the business owner/partners? (In case of partners, more than one can be marked.)
1.( ) University and above 2.( ) Secondary/High School Graduate 3.( ) Primary School Graduate and below
8. Number of people working in the business?
1.( ) Less than 10 2.( ) Between 10-49 3.( ) 50 and above
9. What is the average working time of employees in the company?
1.( ) Less than 6 months 2.( ) Between 6-12 months 3.( ) Between 2-3 years 4.( ) 3 years and above
Part-2 Earthquake Impact on Company Activities
10. Did you experience an earthquake while your company was still operating?

1.( ) Yes 2.( ) No (Please go to Question 17.)

In the table below, for each column (period information), select only one of the options for the relevant variables. For example, the survey can be answered by placing an X to indicate the option that the number of customers decreased by 40%-60% during the earthquake. Then, information on how activities changed in other periods can be entered for the same question.

Change in Company Activities	**Before the Earthquake**	**During an Earthquake**	**1 Week Later**	**After 1 Month**	**After 6 months**
11. Number of Customers?					
No customers came.					
It decreased by 60%-80%.					
It decreased by 40%-60%.					
Decreased by less than 40%.					
There was almost no change.					
12. Company Revenue?					
No income was generated.					
It decreased by 60%-80%.					
It decreased by 40%-60%.					
Decreased by less than 40%.					
There was almost no change.					
13. Company Production (Service delivery)?					
No production/service was performed.					
It decreased by 60%-80%.					
It decreased by 40%-60%.					
Decreased by less than 40%.					
There was almost no change.					
14. Number of Company Employees?					
The employees did not come.					
It decreased by 60%-80%.					
It decreased by 40%-60%.					
Decreased by less than 40%.					
There was almost no change.					
15. How long has the company been in operation?					
There was no change in the duration					

It decreased by 60%-80%.					
It decreased by 40%-60%.					
Decreased by less than 40%.					
There was almost no change.					

16. Will there be a change in your business's turnover during the outage? Can you estimate this change as a percentage of your usual turnover for a week?

.....

Part-3 Expectations Regarding Earthquake

17. What could be the impact on your business's revenue during an outage?

1.( ) Production cut 2.( ) Sales cut 3.( ) Penalties for non-compliance with contracts
4.( ) Increase in production costs 5.( ) Other effects on revenues

18. How long would you postpone your business investment decisions after the outage?

1.( ) I will not change the investment decision. 2.( ) I will postpone it for 1-3 months. 3.( ) I will postpone it for 3-6 months.
4.( ) I will postpone it for 6 months. 5.( ) I will cancel the investment decision.

19. What could be the impact on your business's operations during an outage?

1.( ) Disruption in company organization 2.( ) Workers' stress 3.( ) Decrease in the number of customers
4.( ) Endangerment of employees or customers 5.( ) Partial closure 6.( ) Damage to the company's reputation
7.( ) Order delay 8.( ) Other operational effects

20. Once operational, how long will your operations continue to be affected?

1.( ) 0 days 2.( ) A few days 3.( ) 1-2 weeks 4.( ) 2-4 weeks 5.( ) > 1 months

21. Over the course of a full year, what consequences could the outage have on your activity level?

1.( ) No effect 2.( ) Decrease in activity 3.( ) Increase in activity

22. Is your business dependent on municipal services (drinking water/electricity), ignoring the substitute solutions you have at your disposal (e.g. water tanks) to protect yourself against the risk of service interruptions?

1.( ) Yes, for production 2.( ) Yes, for sale 3.( ) Yes, for the supply chain
4.( ) Yes, for well-being at work 5.( ) Yes, for other reasons

23. How do you reduce the number of employees if there is a decrease in your activities after you are operational after the outage?

1.( ) I do not change the number of employees 2.( ) Paid Leave 3.( ) Unpaid leave 4.( ) Termination of employment contract

24. Do you believe that the business building is solid?

1.( ) Yes 2.( ) No

25. Do you expect a devastating earthquake in the next 30 years?

1.( ) Not possible 2.( ) Low probability 3.( ) Possible Possible 4.( ) Most likely

26. Do you expect a devastating earthquake in the next 10 years?

1.( ) Not possible 2.( ) Low probability 3.( ) Possible Possible 4.( ) Most likely

27. Do you expect a devastating earthquake next year?

1.( ) Not possible 2.( ) Low probability 3.( ) Possible Possible 4.( ) Most likely

28. How much damage do you think the business will suffer after a potentially devastating earthquake?

1.( ) Invulnerable 2.( ) Minor damage 3.( ) Moderate damage 4.( ) Serious damage

Demographic Information and Business Characteristics

In this section, information will be provided about the profile of business owners and officers (job description, age, gender, graduation status, etc.) and the characteristics of the business such as its sector, status, service period, and age of the building, because of the survey conducted on the companies.

	Company owner	Middle manager	Top manager	Total
21-30 years old	4.7	2.3	3.1	10.2

31-40 years old	18.0	5.5	1.6	25.0
41-50 years old	29.7	1.6	6.3	37.5
51-60 years old	16.4	0.8	1.6	18.8
60-65 years old	0.8	0.0	0.0	0.8
61-64 years old	4.7	0.0	0.0	4.7
65 years old and above	3.1	0.0	0.0	3.1
Total	77.3	10.2	12.5	100.0

	Male	Female	Total
Primary school graduate and below	**8.6**	**3.1**	**11.7**
Company owner	7.8	2.3	10.2
Senior manager	0.8	0.8	1.6
Senior/secondary school graduate	**39.1**	**18.8**	**57.8**
Company owner	29.7	14.1	43.8
Middle manager	6.3	1.6	7.8
Senior manager	3.1	3.1	6.3
University and above	**21.9**	**8.6**	**30.5**
Company owner	18.0	5.5	23.4
Middle manager	0.8	1.6	2.3
Senior manager	3.1	1.6	4.7
Total	69.5	30.5	100.0

	Incorporated company	Limited company	Sole Proprietorship	Total
Agriculture-Animal Husbandry	0.0	0.0	0.8	0.8
Manufacturing-Production	0.8	3.9	7.0	11.7
Services	1.6	5.5	12.5	19.5
Trade	0.8	7.8	58.6	67.2
Tourism	0.0	0.8	0.0	0.8
Total	3.1	18.0	78.9	100.0

Building Age\Business Activity Period	Less than 3 years	3-5 years	More than 5 years	Total
5-10	0.8	3.9	2.3	7.0
11-15	1.6	2.3	4.7	8.6
16-20	0.0	3.9	8.6	12.5
21-25	0.8	0.0	10.9	11.7
26-30	0.0	2.3	10.2	12.5
31 and above	3.9	6.3	37.5	47.7
Total	7.0	18.8	74.2	100.0

Average Working Time \ Company Size	Less than 10	Between 10-49	50+	Total
Less than 6 months	1.6	0.0	0.0	1.6
6-12 months	14.1	1.6	0.0	15.6
2-3 years	24.2	0.8	0.0	25.0
3 years and above	51.6	5.5	0.8	57.8
Total	91.4	7.8	0.8	100.0

Suitable for Remote Work\Company Operation Period	Less than 3 years	Between 3-5 years	More than 5 years	Total
Yes	0.8	0.0	6.3	7.0
No	6.3	16.4	66.4	89.1
Partially	0.0	2.3	1.6	3.9
Total	7.0	18.8	74.2	100.0

INDUSTRIAL POLICY
A Scientific Journal Dedicated to Economic Development and Industrial Policy

OPEN ACCESS

Research Article

www.indpol.org

10.61192/indpol.1485611

IndPol, 2024; 4(2): 75-89

Industrial Policy and Green Growth in a Small Island Economy: The Case of Singapore

Saim Karabulut[a]

[a]Project Development and Management Office, OSTIM Technical University, Ankara, Türkiye, 0000-0002-4435-1780

Abstract

This article analyses how Singapore has managed to achieve a successful development process despite its limited natural resources and how it has achieved environmental sustainability through green growth strategies. Singapore's industrial policies and green growth strategies offer significant lessons for other economies and set an important example for achieving sustainable development. The paper considers the leading role of the state, leadership and commitment to national/international commitments as determinants of Singapore's development success. Efforts such as the Green Growth Plan and participation in the carbon market are proving the effectiveness of integrated policy approaches and contributing to social welfare while enhancing national competitiveness. Overall, Singapore's experience offers important lessons for economies seeking sustainable growth and contributes to the development economics research literature. And non-state actors' governing pathways to enhance land productivity and foster comprehensive agro-development.

Article History
Received September 30, 2024
Accepted November 19, 2024

Keywords
Developmental Economics, Industrial Policy, Sustainable Development, Singapore, Green Economy

JEL Codes
O2, O4

1. Introduction

The concept of economic development, which is based on sustaining a welfare worthy of human dignity, has an important place in academic studies. In short, development economics, a branch of science that examines the processes of increasing the economic welfare of low and middle income countries, focuses on some fundamental questions. It focuses on basic problems such as the disparity in levels of development between countries or the state's role in development processes. This discipline has become even more important in the last hundred years. In other words, it no longer focuses only on increasing the level of welfare, but also on how to achieve and sustain environmentally sound growth. But can social welfare be increased without harming the environment, can major growth imbalances between countries be brought to a more equitable position, as well as promoting a way of life worthy of human dignity? Environmentally sensitive development has now moved from theory to practice. These practices have gone beyond voluntary efforts and continue to evolve into mandatory regulations day by day. The best example of this is the gradual transition to carbon emissions management by mandatory mechanisms based on the idea that voluntary mechanisms are insufficient. Sustainable economic policies are becoming increasingly important within these limits, revealing the necessity of development without conflicting with nature. Industrial policies are considered as an important instrument of

CONTACT Saim Karabulut saimkarabulut0612@gmail.com

economic development. Countries in transition from an agricultural to a post-industrial economy have implemented selective government policies. The importance of these policies was realized especially after the Second World War where they were used to repair war damages.

Dani Rodrick argues that the government's support for certain economic activities more than others indicates the implementation of industrial policies. Yülek (1991), on the other hand, defines these policies as incentives applied in countries' priority industrial areas. In the 1980s, with the rise of neo liberal economics, state intervention was tried to be reduced, but in the 1990s, the mainstream economy again turned towards industrial policies. During this period, general effective horizontal industrial policies were preferred. However, further research has revealed the importance of extensive state intervention in the success of East Asian countries. In 2000s, the need for active industrial policies for late industrializing countries was highlighted. Nowadays, the issue of how to design and implement industrial policy has become important. The global economy is experiencing a transformation with the paradigm of sustainability and green growth emerging. The transformation brings significant opportunities alongside its challenges for countries. At this point, the study examines Singapore as a case study, which is an excellent lesson for countries at all stages of development that take advantage of the opportunities of green economic transformation.

Singapore's development journey serves as a significant example in development economics. Despite limited natural resources and geographic constraints, Singapore has achieved notable success through innovative industrial policies and green growth strategies. By analysing Singapore's economic development, policies, and strategies, this study aims to provide valuable insights for other economies. Singapore's experience highlights key lessons for achieving sustainable growth and implementing green industrial policies, focusing on leadership, state involvement, and adherence to national and international commitments. Through both quantitative and qualitative analysis, the study illustrates Singapore's successful development since its independence in the 1960s, highlighting its management of green policies within the context of green growth. The analysis is based on a case study, compiled and evaluated through literature studies and key indicators included in the scope. This article is extracted from my master's thesis entitled “Industrial Policy and Green Growth in a Small Island Economy: The Case of Singapore,” supervised by Prof. Dr. Murat Ali Yülek, completed in 2024 (Master’s Thesis, OSTIM Technical University, Ankara, Turkey, 2024).

2. Methodology

Given the context of development economics, this study aims to analyse Singapore's sustainable economic development processes. It analyses the effects of green industrial policies on green growth through case studies. Qualitative and quantitative descriptive analysis method is used to demonstrate how Singapore's development journey has been successful since its independence in the 1960s and how it has recently displayed the same success in sustainable development in terms of green growth. In this case study, topics such as development economics, industrial policies, green industrial policies are also explained and related matters are also analysed. In order to cover the scope of the research topic, qualitative and quantitative data were collected from the literature and the data were compiled in the light of important indicators and analysed through a descriptive case study.

3. Literature Review and Discussion

3.1. Development Economics and Economic Growth

While the development economy began as a focus on the growth of third world countries, it has expanded in scope and impact over time. Early debates about the field centered on its definitional limitations. The basic principles of development economics, as noted, were shaped after the Second World War to understand and foster the development of the Third World. Todaro and Smith (2020) note these principles as crucial to the design of future economic development policies. The historical context and ongoing debates continue to shape the way Development Economics addresses global development challenges. Though there is no consensus on definitions, J. Edward Taylor and Travis J. Lybbert (2020) define development economics broadly as follows; “Seeking to understand the economic aspects of the development process in low income countries. Economic development entails far reaching changes in the structure of economies, technologies, societies, and political systems. Development economics is the study of economies that do not fit many of the basic assumptions underpinning economic analysis in high income countries, including well-functioning markets, perfect information, and low transaction costs”. The 1950s saw significant debates in development economics, particularly between balanced and unbalanced growth theories. Key figures such as Albert Hirschman and Paul Rosenstein-Rodan championed different strategies; Rosenstein-Rodan advocated for broad based investments (the Big Push), while Hirschman supported targeted investments in key sectors to stimulate growth. W. Arthur Lewis introduced the dual sector model, focusing on the shift from agriculture to industry, which has greatly influenced modern economic development policies.

The Bretton Woods Conference, held after World War II, significantly changed the concept of development by emphasizing the importance of supporting underdeveloped nations to ensure global economic growth. The conference aimed to establish a fixed exchange rate regime and enhance international trade, marking the start of a new era in global economic policy and development. Economic development is driven by enhancing work skills and intelligence, coupled with technological advancements that transform traditional societies. It involves the use of capital to improve productivity, generate wealth, and increase national income, while also incorporating social and cultural changes. Effective

economic development depends on a mix of labor, capital, and institutional, cultural, and technological factors, leading to innovation, urban specialization, and sustainable prosperity through improved capabilities and responsible practices (Frenken and Boschma, 2007; Feldman et al., 2016).

Economic growth, according to Freyssinet (1985) and Özgüven (1988), is the measurable increase in an economy's productive capacity over time, improving societal well-being and income. This aligns with Adam Smith's concept of expanding production, illustrated by the outward shift of the production possibility frontier (PPF) as resources and technology advance. This change reflects the increase in an economy's capacity to produce goods and services with existing resources and technology, essentially the essence of economic growth. The Production Possibility Frontier (PPF) is a crucial tool in understanding economic growth and represents the maximum production level achievable with current resources and technology. An increase in resources or their quality causes the PPF to expand, indicating economic growth, which is measured by the annual growth rate of national income or per capita income. Economic growth and development have been defined in various ways by key economists. Denison measures it through GNP and GDP, while Sen emphasizes personal freedom and expanding capabilities. The UNDP uses the Human Development Index, and Kuznets' hypothesis links income inequality with economic growth in an "inverted U" curve (Denison, 1962; Rostow, 1960; UNDP; Kuznets, 1955).

3.2. Economic Growth Theories

A better comprehension of development processes becomes even more meaningful when considered in the perspective of the historical development of economic growth theories. This section will focus on economic growth theories. Firstly, pre classical growth theories, such as mercantilism and physiocracy, provide the foundations of economic growth. Merkantilism claimed economic power could be increased through foreign trade and the accumulation of precious metals between the 16th and 18th centuries (Özgüven, 1988), while physiocracy argued that the main source of prosperity was agricultural production and that state intervention should be minimal by adopting the laissez-faire principle (Aksu, 2018). Classical growth theories appeared in the late 1800s and analyzed the role of the market in economic growth. On the other hand, Keynesian growth theories criticized classical economic theories and considered government intervention essential for the recovery of the economy. Keynes (1936/2017) maintained that demand is the main determinant of employment and income levels in the economy and argued that investments should be increased. Later on, this view was made more dynamic within the framework of sustainable growth with the efforts of Harrod and Domar (Greenlaw and Shapiro, 2011; Greenwald and Stiglitz, 1987).

Neoclassical growth theories emphasize sustainable economic growth through the interaction of labor, capital and technological progress (Spencer, 2008). These theories have been at the center of economic growth research, especially after the Second World War. Robert Solow's Nobel Prize winning "Solow Model" and the Mankiw-Romer-Weil model are important contributions to this theoretical framework. These models are based on the assumption that the market is competitive and an increase in production inputs leads directly to an increase in output (Kose, Prasad, Rogoff, and Wei, 2010). Milton Friedman's monetarist growth theory advocates for tight monetary policy to stimulate economic growth, suggesting a short-term balance between inflation and unemployment, but none in the long run (Greenlaw and Shapiro, 2011). In contrast, endogenous growth theories highlight technological progress and human capital as internal drivers of growth. Models by Rebelo (1991), Romer (1986), Aghion and Howitt (1992), and Lucas (1988) stress the importance of skills, knowledge, and public investment in shaping long-term economic growth.

3.3. Total Factor Productivity

The theory of total factor productivity (TFP) argues that economic growth relies not just on more inputs but crucially on technological advancements. Solow's (1957) work laid the foundation for using TFP to assess productivity's impact on growth, particularly in the US (Shackleton, 2013). TFP has demonstrated that productivity growth, particularly within the manufacturing sector, is a pivotal factor in economic development (Balakrishnan and Pushpangadan, 1994). As a principal catalyst for economic expansion, TFP possesses the potential to enhance efficiency in capital and labor through enhanced managerial techniques and reduced production costs (Yülek, 2018; UNDP, 2018).

3.4 Industrialization, Industrial Policy and Deindustrailization

As posited by Kaldor, industrialization is becoming an increasingly pivotal concept within the academic community, serving as the primary catalyst for economic growth. In light of these considerations, it is imperative to examine industrial policies in conjunction with the industrialization process. The Industrial Revolution, which emerged in the 18th century, constituted a radical transformation of economic, technological, and social structures. The transition from economies based on agriculture and manual labor to systems based on industry and mechanization resulted in significant changes to production processes. Cities developed at a rapid pace, the middle class grew, and working conditions and labor rights underwent significant transformations. This process established the foundations of modern industrial economies and significantly contributed to the current structure of the global economy (Hartwell, 1990).

Yülek (2017) views industrialization as a capacity building process involving stages from machinery introduction to new product development, emphasizing skills and technical competencies. The process isn't always linear, with some countries potentially stalling at certain stages, leading to middle income or technology traps. The three critical factors

for successful industrialization are skills, technical progress, and capabilities. Industrial policy plays a crucial role in the industrialization process, shaped by historical shifts like Britain's transition in the 18th century and evolving through phases: pre-1970 import substitution, 1980s liberalization, and recent digital development and SME support. Modern policies focus on sustainable growth, technical capacity, and public private partnerships (Aiginger and Rodrik, 2020). Successful policies integrate macroeconomic and social elements, as demonstrated by East Asian Tigers, which used strategic state interventions to foster development beyond neoliberal models. Deindustrialization, a decline in manufacturing output and employment, must also be considered in this context. It is often associated with the rise of the service sector in advanced economies. This process serves to reinforce the significance of industrial policies in ensuring economic stability, fostering innovation, and promoting exports (Tregenna, 2010; Rowthorn and Wells, 1987). Industrialization and industrial policies represent the fundamental dynamics of economic growth and sustainable development. The function of industrial policies in economic development is not merely to rectify market failures; it is also to reinvigorate "forgotten regions," thereby contributing to the greater social good. One of the most significant elements of contemporary industrial policies is their emphasis on technological innovation and the capacity of developing economies to reconcile imitation and innovation strategies (Rodrik, 2004).

Observed variables that are linked with the latent construct of agro-production, while another latent variable, local agro-governance, is characterized by four observed variables, and land productivity serves as an endogenous variable (Figure 3).

3.5 Green Economy and Green Growth

Green economy dates back to the recognition of sustainable development as a global policy goal. It was emerged from the search for environmental awareness and sustainable development. Rachel Carson's "Silent Spring" (1962) and the Club of Rome's "The Limits to Growth" (1972) contributed to the acceleration of this debate by drawing attention to the consequences of environmental degradation and limited natural resources. Sustainable development was formalized with the Brundtland Report published in 1987 and transformed into the concept of green economy. According to UNEP (2011), green economy is defined as "an economy that significantly reduces environmental risks and ecological scarcities while improving human well being and social equity". UNEP's 2009 Global Green New Deal (GGND) proposes key policies to reduce carbon emissions and protect ecosystems, advocating for economic models like carbon trading and payments for ecosystem services. The green economy comprises elements such as cleaner production, resource efficiency, circular economy, and nature-based solutions, aiming for efficient resource use and sustainable cycles (Louseau et al., 2016). However, critics like Kosoy and Corbera (2010) argue that commodifying nature as "ecosystem services" oversimplifies complex ecological dynamics and marginalizes vulnerable communities. Green growth is an economic model within sustainable development, addressing environmental, economic, social, and ecological challenges (Bowen, 2012). It complements sustainable development, integrating the dual focus on environmental sustainability and economic progress (Kuşat, 2013). Seçgel (2007) states that green growth is an integrated approach that includes concepts such as sustainable urban management, emission control, green employment, low carbon economy and clean product design. Green growth functions as an economic policy and development strategy and is considered as a potential tool in finding solutions to global problems (Arlı Yılmaz, 2014).

3.6. Essential Terms in Green Growth

3.6.1 Low carbon economy, carbon footprint and ecological footprint

Low carbon economy is a solution to address climate change that carries not only an environmental but also a social and economic dimension. This transition requires the development and implementation of low carbon technologies to achieve countries' goals of reducing greenhouse gas emissions and lowering their carbon footprint low carbon economy especially after the 2008 global financial crisis has been adopted as a critical solution and aims to reduce the carbon dependency of economic activities in order to reduce greenhouse gas emissions. The United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol have played an important role in the adoption of the low carbon economy concept at the international level, setting specific targets for managing and reducing greenhouse gas emissions (Lütken et al., 2011). Copenhagen Summit in 2009 was recognized as an important milestone in global climate policies and raised climate change awareness in developing countries. Studies show that measures to reduce greenhouse gas emissions have the potential to prevent economic losses and be financially profitable. After the 2008 economic crisis, several countries integrated low-carbon measures into their stimulus packages, enhancing the adoption of a green economy model. Since the 1970s, unsustainable resource use has led to environmental crises. The 2022 WWF Living Planet Report highlights drastic biodiversity loss, with wildlife populations declining by 69% globally since 1970, underscoring the need for urgent change. Tools like carbon and ecological footprints have been developed to measure human impact on natural resources. The carbon footprint measures greenhouse gas emissions from activities, playing a critical role in climate change mitigation, as supported by international agreements like the Paris Climate Agreement. The ecological footprint, introduced by Wackernagel and Rees in the 1990s, assesses whether consumption exceeds the planet's regenerative capacity. Both metrics are essential for understanding and reducing our environmental impact (WWF, 2022).

3.6.2 Global warming, climate change, and the greenhouse effect

Global warming refers to the rise in Earth's average surface temperature due to natural processes and human activities, primarily driven by the greenhouse effect involving gases like carbon dioxide and methane (Hansen et al., 2010). Fossil fuel combustion and deforestation are significant contributors to global warming, particularly since the Industrial Revolution. The UNFCCC defines climate change as alterations in atmospheric composition caused by human actions (UNFCCC, 2002). The IPCC's 2023 Sixth Assessment Report confirms human activities, especially greenhouse gas emissions, as the primary cause of global warming. It highlights that global temperatures rose by 1.1°C between 2011-2020 compared to 1850-1900, with CO2 and methane levels significantly elevated. The report calls for urgent actions, such as reducing fossil fuel use, transitioning to renewable energy, and protecting forests.

3.7. International Regulations Green Growth

3.7.1 The Paris Agreement

The United Nations Framework Convention on Climate Change (UNFCCC) was established in 1992 at the United Nations Conference on Environment and Development to address climate change and reduce greenhouse gas emissions. Annual Conferences of the Parties (COP) are held to discuss emission reduction and environmental protection. Under the UNFCCC, key agreements like the Kyoto Protocol (1997) and the Paris Agreement (2015) were signed to set formal emission reduction targets. The Paris Agreement represents a new international legal regime to strengthen the fight against global climate change. This agreement replaces the Kyoto Protocol, providing flexibility for all countries to commit to emission reductions regardless of their development status. Kyoto Protocol only imposed obligations on developed countries, and the US non ratification and rising emissions in developing countries showed that this approach was insufficient. 2009 Copenhagen Conference and the Durban Platform laid the groundwork for the Paris Agreement and established that a new all party agreement should be in place by 2015. Paris Agreement provides for countries to submit their nationally determined contributions (NDCs) and for these contributions to be monitored based on transparency and collective assessment mechanisms (according to the transparency and accountability rules adopted at COP24). The Agreement adopts a bottom up approach based on the principle of "common but differentiated responsibilities and relative capabilities". It also renews the commitment of developed countries to provide $100 billion in financial support to developing countries each year, proposes new mechanisms to allow international trading of emission reductions, and aims to support vulnerable countries, such as small island states, which are most affected by climate change. The Paris Agreement was the first agreement to demand serious efforts from all parties to combat climate change and remains at the center of global efforts in this area.

3.7.2 Sustainable development goals

The concept of sustainable development originated with the United Nations Charter for Nature in 1982 and was elaborated in the 1987 "Our Common Future" report and the 1992 Earth Summit. Sustainable development seeks to balance economic growth with environmental conservation. The integration of social development as a "third pillar" was highlighted in subsequent summits, such as the 1995 Copenhagen and 2002 Johannesburg Summits (Hak et al, 2016). In 2015, the United Nations adopted the Sustainable Development Goals (SDGs), building on the Millennium Development Goals (MDGs) to address broader issues, including poverty reduction, environmental sustainability, and social inclusion. The 2023 SDG Report indicates that only 15% of the assessed targets are on track for 2030, with nearly half significantly deviating from the intended path. Over a third have seen no progress or have regressed since 2015, underscoring the need for urgent and intensified efforts. Key challenges include economic growth and green economy targets, which have been affected by the COVID-19 pandemic, climate change, and growing inequalities. Accelerating the green economy transition and reforming international financial systems are crucial to achieving sustainable development (United Nations, 2023).

3.8. Regional Regulations

3.8.1 European Union Green Deal

The European Green Deal (EGD) is a strategic plan to turn environmental challenges into opportunities, aiming to align the EU's economy with sustainability while ensuring a fair and inclusive transition (Claeys et al., 2019). The EGD seeks a resource independent growth model, targeting net zero greenhouse gas emissions by 2050. It includes investments in clean technology, industrial innovation, clean transport, energy sector decarbonization, and improved energy efficiency in buildings. It also focuses on biodiversity protection and pollution reduction, impacting sectors like energy, construction, transport, and finance. According to the European Parliament, the goal of climate neutrality requires significant changes in economic growth and sectoral production. Within the scope of the EGD, the EU has aimed to accelerate the green transition through various initiatives. In this regard, initiatives such as zero emission city buses target by 2030, renewable hydrogen rules and Green Deal Industrial Plan have been developed. In addition, the renewable energy target was set at 42.5% by 2030 and an 11.7% improvement in energy efficiency was targeted. Social Climate Fund launched to support vulnerable households and small businesses to reduce the cost of the green transition. EU's Carbon Border Adjustment Mechanism (CBAM), which aims to prevent carbon leakage in international trade, aims to internalize the carbon footprint of imported products and provide a climate friendly perspective on international trade. CBAM came into force in 2023 and a carbon fee based on the

carbon emissions of imported products will be charged from 2026.

CBAM aims to offset the carbon costs of imported and domestic products by implementing rules in line with the EU's emissions trading system (EU ETS) (European Commission, 2023; Perdana and Vielle, 2023). The European Green Deal (EGD) adopts a multidimensional strategy that focuses on decarbonization while also enhancing Europe's long-term economic growth and international competitiveness. It aims to revitalize Europe's industrial potential, turning the transition into an industrial opportunity, particularly amidst rising competition from China and other major economies (Claeys et al., 2019; Fetting, 2020).

4. Green Industrial Policies

Green Industrial Policies seek to align economic growth with environmental sustainability by integrating innovation and enhancing industrial competitiveness. In developing countries, green growth forms part of broader sustainable development strategies (Borel et al., 2013). Unlike traditional industrial policies, green industrial policies differ in terms of government intervention scale, policy duration, and the complexity of performance-based evaluation (Petrashko, 2017). Dani Rodrik (2014) analyzes the theoretical strength and practical uncertainties of green industrial policies, arguing that government support is necessary to address market failures in innovative technologies. Rodrik highlights how positive externalities arising from the development of new technologies, inaccuracies in carbon pricing and competitive incentives lead to the need for government intervention. Green industrial policies support these “baby” industries by appropriately pricing environmental externalities in the market (Morris, Nivola and Schultze, 2012). Such policies address not only environmental but also other challenges faced by conventional industries. Moreover, the promotion of local innovation is another important element of green industrial policies. Policies aim to advance low carbon energy technologies, energy storage solutions and green cars. However, it is argued that these policies have the potential to disrupt international trade and investment flows, creating legal issues under WTO laws (International Institute for Sustainable Development and United Nations Environment Programme, 2014). Whereas traditional industrial policy focuses on short term competition and economic growth, the new industrial policy aims for long term societal benefits and overall social welfare (Ambroziak, 2017; Rodrik, 2014, 2020). Rodrik's (2014) proposal advocates a collaborative effort between the public and private sectors to create an economy that provides quality job opportunities.

The European Green Deal highlights the relationship between the social welfare objectives of industrial policies and the decarbonization objectives of climate policy. This provides a dual focus that distinguishes the GIP from both climate policy and industrial policy: decarbonization and enhancing social welfare. However, if these objectives conflict, resolving this contradiction and, if necessary, developing new policy instruments is one of the main challenges of the GIP. Besides classical market failures, Green Industrial Policy also addresses specific problems, such as greenhouse gas externalities specific to climate change. Although carbon pricing has been proposed to correct such externalities, in the absence of an effective carbon price, alternative methods, such as regulations or public investments, may be required (Tagliapietra and Veugelers, 2020). GIP should contain different and complementary policy instruments in addition to traditional industrial and climate policies, and these instruments should be compatible with existing mechanisms such as carbon pricing. Public funding for innovation and R&D is emphasized for developed countries, while technology transfer and capacity building are prioritized for developing countries. Carbon pricing, public private partnerships and green market creation measures are emphasized in both developed and developing countries. This shows that the GIP sits at the intersection of climate policy (decarbonisation) and industrial policy (social welfare). The challenge of the GIP is that these two objectives need to be realized simultaneously. While carbon pricing is preferable to reduce carbon emissions, second order interventions may be required when it is not sufficient. Therefore, the GIP should integrate specific instruments to support the transition to a low carbon economy and align with climate and industrial policies (Tagliapietra and Veugelers, 2020).

5. Industrial Policy and Green Growth in A Small Island Economy: The Case of Singapore

Singapore's transformation from a classic British trading center to a high income country in the 1960s is a striking example of successful strategic public policy and economic planning (Heng, 2015; Yülek, 1998). Soon and Tan (1993) noted that Singapore implemented only one five year development plan in its development process, the Singapore Development Plan 1960-64, and thereafter did not continue with fixed term planning. Economic independence of Singapore gained a major push when it gained political independence from Malaysia in 1965, and the country's economic orientation shifted from import substitution to export oriented industrialization. This new approach aimed to make the most efficient use of Singapore's strategic location between Eastern and Western markets. In the period that followed, Singapore became a center for trade and investment, attracting global investment in key sectors such as financial services, information technology, medical services, electronics, aviation, and education, leading to a huge increase in its Gross Domestic Product (GDP). Yülek (1998) emphasizes these policies as flexible, rational and effective. Unlike Hong Kong, which has a similar structure, Singapore is characterized by intensive and significant state interventions in the economy; these interventions are targeted towards the development of specific sectors. The model, where the state plays an active role in the economy, supported by public institutions and enterprises, is seen as a key driver of success in the development process. Sectoral focus of the state has

accelerated and sustained economic growth by directing public investment and resource allocation to priority areas for development.

Since 1959, Singapore started its economic transformation with inward oriented development policies (Phase 1: 1959-1967). During this period, an import substitution industrialization strategy adopted against rising unemployment and changes in global trade patterns, and tariffs and quotas were implemented. However, the limited domestic market and inefficiencies in the local manufacturing sector prevented the success of this strategy (Yülek, 1998). After its separation from Malaysia in 1965, Singapore became more open to foreign investment and embarked on an export oriented industrialization process. Such transformation was supported by the establishment of institutions such as the Economic Development Board (EDB) and investments in strategic sectors. However, foreign investments did not reach the expected level and this situation increased Singapore's difficulties in economic transformation (Yülek, 1998; Mun Heng, 2015). In the period 1968-1978, Singapore adopted an outward oriented development policy and shifted to an export oriented strategy (Phase 2: 1968-1978). Foreign investment and exports were sought to be increased with the enactment of the Economic Expansion Promotion Act. Labor and employer relations were regulated with the establishment of the National Wages Council (NWC) and wage policies were aligned with international competitiveness (Yülek, 1998). These policies made Singapore an attractive center for foreign direct investment (FDI) and attracted significant investments in key sectors such as electronics and petrochemicals. Foreign Direct Investment (FDI) refers to an investment by a company or individual from one country into a business located in another country, often involving ownership control. FDI is significant as it supports domestic investment, boosting capital accumulation, productivity, and economic growth in the host country. It offers stable financing for current account deficits, creates jobs, and facilitates the transfer of technology and managerial skills, particularly beneficial for developing countries. However, FDI can also have drawbacks, like economic instability and profit repatriation. Therefore, strategic investment policies are necessary to ensure that FDIs yield maximum net benefits for the host country rather than simply liberalizing all inflows Singapore exemplifies FDI driven growth, especially between the late 1950s and 1970s, where its main goal in attracting FDI was to create jobs. With limited domestic technological capabilities, Singapore focused on attracting mid-level technology transfers to support its economic development (Yülek and Gür, 2017). The 1973 oil crisis notwithstanding, the economy continued to grow and the investments made during this period supported economic diversification (Mun Heng, 2015).

From 1979-1985, Singapore aimed to shift from low value added and labor intensive industries to capital and technology intensive sectors (Phase 3: 1979-1985). Labor qualifications were improved through measures such as wage increases and the Skills Development Fund (SDF), while the Economic Development Board (EDB) coordinated investment in specific sectors. This policy helped Singapore maintain its competitive advantage and transition to higher value added production (Yülek, 1998; Mun Heng, 2015). Following the economic recession of 1985, the "Singapore Economy: New Directions" report, prepared to overcome the 1985 economic stagnation, recommended lowering taxes and labor costs, which accelerated economic growth (Phase 4: 1986-1997). The Strategic Economic Plan (SEP) focused on human resource development, innovation and increasing competitiveness. During this period, the manufacturing sector was directed towards sub sectors such as electronics, telecommunications and aerospace, and industrial clusters were developed (Mun Heng, 2015; SEP MTI, 1991). Between 1998 and 2008, following the Asian Financial Crisis, Singapore took fiscal measures and started the process of transformation to a knowledge based economy through initiatives such as Industry 21 and Manpower 21 (Phase 5: 1998-2008). The Biomedical Sciences (BMS) sector and NEWater projects to manage water resources contributed to the country's sustainability goals. In this period, free trade agreements were signed to increase international trade advantages and Integrated Resort (IR) projects were implemented to revitalize tourism (Mun Heng, 2015; Yülek, 1998).

Phase 6: 2009 and beyond (Phase 6: 2009 and beyond) marked a period of slow economic recovery as Singapore struggled to recover from the effects of the 2008 Global Financial Crisis (GFC). During this period, demographic aging and productivity issues came to the fore, and the Economic Strategies Committee (ESC) developed seven strategies to boost productivity and revitalize the economy. Policies focused on R&D and innovation supported the transition of the economy to higher value added areas. Moreover, environmental sustainability goals such as the Green Plan 2030 allowed Singapore to integrate its economic development with a sustainability perspective. During this period, Singapore consolidated its position as a global economic player (Loong, 2011; Mun Heng, 2015).

5.1. The Structure of Singapore's Economy

Noted for its high income level, advanced market economy and its position as a global financial and trade center, Singapore is recognized as one of the most open and competitive economies. Its economic structure is supported by high tech manufacturing, strong international trade networks and an efficient service sector. Singapore's economic rise has been built on private sector growth, export led strategies and attracting foreign investment. Despite limited natural resources, the country has adopted a development approach based on efficiency, thus consolidating its place in the global economy. A review of economic indicators shows that Singapore ranks 34th in the global economy and second globally in per capita income (World Bank data). In 2022, the economy grew by 3.6%, with growth of 2.5% in manufacturing, 6.7% in construction and 4.8% in services. Inflation rose to 6.1%, while unemployment fell to 2.1% (MTI, 2022; Singapore Department of Statistics, 2023).

ASEAN is expected to become Asia's third largest economy with a GDP of USD 3.6 trillion in 2022, and Singapore's contribution to this union is of great importance. Singapore stands out as a major producer of electronic and chemical products and has harmonized with international tax standards and raised its goods and services tax (GST) rate to 9% (Deloitte, 2023). Singapore ranked fifth in the Global Innovation Index in 2023, ranking high in government effectiveness and access to venture capital. In line with the Paris Agreement, the country increased its carbon tax and took important steps to combat climate change (Dutta et al., 2023).

5.2. Manufacturing Value Added and Its Per Capita Impact in Singapore's Economy

Moving from a low cost labor intensive production model to high value and technology intensive production, Singapore's manufacturing sector contributed 20.5% to GDP in 2022. The "Manufacturing 2030" plan aims to boost manufacturing's share of GDP by 50%, focusing on digitalization, advanced technologies, and workforce skill development. In response to the pandemic and geopolitical challenges, Singapore has emphasized strengthening its domestic manufacturing base by encouraging smart manufacturing solutions through initiatives like Industry 4.0 and NAMIC. Industry Transformation Maps (ITMs) target creating 13,400 new jobs and contributing 80% of annual manufacturing output by 2025. Technologies like AI, data analytics, and IoT are crucial in accelerating industry digital transformation and supply chain management. In 2022, Singapore ranked 26th globally in manufacturing, with a per capita value added of USD 14,112, highlighting its sector's efficiency and productivity. Over the period 2000-2022, there has been an overall increase in manufacturing value added per capita despite periods of crisis, demonstrating Singapore's resilience and capacity for strategic transformation in the manufacturing sector. Singapore ranks 9th in the United Nations Industrial Development Organization's (UNIDO) Competitive Industrial Performance (CIP) Index and third in terms of manufacturing value added per capita (UNIDO, 2023).

5.3. Science and Technology Development in Singapore

Starting with digitization in the public sector, Singapore's science and technology policy has evolved into IT mainstreaming in the private sector and the integration of technology into urban planning. Government's adaptability, interagency collaboration and partnerships with multinational companies have played an important role in this transformation (Erh, 2023). In the 1960s, the foundations of science and technology were laid with institutions such as the Ministry of Science and Industry and the Singapore Institute of Standards and Industrial Research. An R&D culture was developed with the National Science and Technology Council (1991) and the National Technology Plan (1995), and institutions such as A*STAR and SPRING were established. Thus, Singapore has created a favorable R&D environment for the transition to a knowledge based economy.

5.4. Science and Technology Plans

Launched in 1995, the National Technology Plan encouraged R&D activities in nine key sectors with an investment of SGD 2 billion. In 2000, the National Science and Technology Plan expanded the science and technology infrastructure with a budget of SGD 4 billion and made significant progress, particularly in the biomedical sector. Subsequently, the Science and Technology Plan in 2005 supported the biomedical sciences (BMS) sector and increased R&D spending to 2.25% of GDP. This was followed by the Science and Technology Plan in 2010, which increased R&D spending to 3% of GDP with SGD 13.55 billion invested in growth sectors such as environmental technologies and digital media. By 2015, the RIE2015 Plan had developed six strategies aimed at accelerating the commercialization of R&D and supporting public and private partnerships in basic science. Finally, the RIE2020 Plan, launched in 2020, aimed to strengthen Singapore's status as an innovation driven economy, adapt R&D to industry needs, and support the startup ecosystem with a budget of SGD 19 billion (Ministry of Trade and Industry, 2024; Economic Development Board, 2024).

5.5. Education in Singapore

Due to its limited natural resources, Singapore has invested in human resources to compete globally. Its education system has consistently ranked highly in the OECD's PISA assessments. Even though education spending will reach 2.8% of GDP in 2021, success has been achieved through high efficiency and quality (Ministry of Education Singapore, 2019; World Economic Forum, 2015). The National University of Singapore and Nanyang Technological University rank highly in world rankings and Singapore ranks second in PISA. The education model has undergone three stages of development, focusing on survival, efficiency, and ability, enabling students to excel in science and mathematics, and offering an individualized, interdisciplinary curriculum (Kozma, 2011). The education system is regulated by the 1957 Education Act and administered by the Ministry of Education. Primary education consists of four years of basic education and two years of orientation; national exams determine students' future educational paths. Education aims to provide cultural and linguistic competence while maintaining multilingualism and allowing students to develop their interests and talents (Ferris and Waldron, 2023). Singapore has 45 higher education institutions and six autonomous universities. Lifelong learning and training programs for graduates are also available. NUS's "Lifelong Learners" (L3) program aims to support its graduates for 20 years, while the SkillsFuture national movement provides lifelong learning opportunities for all Singaporeans (Ministry of Education, Singapore, 2024).

5.6. Research and Development (R&D) Expenditures and Patent Applications in Singapore

Research and development expenditures and patent applications in Singapore are among the important indicators of economic growth and innovation in the process of realizing the country's innovation oriented economy vision. Maradana et al. (2017) reported that R&D expenditures are positively correlated with the number of publications, citation rate and H-index, which supports scientific and technological progress. In this respect, Singapore has made a significant investment in this area by allocating 1.92% of its GDP to R&D expenditures in 2022 (Ministry of Trade and Industry Singapore, 2024) found that there is a long run relationship between R&D investments and total factor productivity over the period 1978-2019. Despite the fact that Singapore lags behind OECD countries in the short run, the economic impact of R&D investments has been stronger in the long run (elasticity ≈ 0.083). Public R&D expenditures stimulate private sector R&D activities and create significant externalities. As of 2020, the majority of patent applications in Singapore were filed by foreign multinationals and public research institutes. New patent laws introduced since 1995 and the "positive approval" system introduced in 2013 aim to improve patent quality and ensure compliance with international standards. In this regard, Singapore has adopted the goal of becoming a global center for intellectual property rights and has developed the Singapore Intellectual Property Strategy (SIPS) 2030. SIPS 2030 focuses on three main areas. First, it aims to enhance regional IP enforcement through initiatives such as the Patent Prosecution Highway (PPH) and the ASEAN Patent Examination Cooperation (ASPEC) to strengthen as a Global IP Hub. Secondly, to Attract and Grow Innovative Companies, it promotes the innovation ecosystem by introducing accelerated patent processes for AI and big data innovations. Finally, under Skilled Business and Skills Development, it aims to make Singapore an international IP dispute resolution center and increase training capacity in this field (Intellectual Property Office of Singapore, 2021). Programs such as RIE2020 and RIE2025, launched to boost R&D and patenting activities, support Singapore's innovation and technological development by offering comprehensive investments in this field. These programs and adjustments in intellectual property laws have contributed to the country's vision of transformation to a knowledge based economy by supporting the increase in patent applications (Chen and Puttitanun, 2019). As a reflection of this vision, the number of domestic patent applications per million people in Singapore in 2022 is recorded at 303, reinforcing the country's status as an innovation hub (WIPO, 2024).

5.7. Macroeconomic Indicators

Singapore's macroeconomic indicators have fluctuated significantly since the 1960s and the country's economic policies have evolved in line with global developments. Industrialization policies implemented in the 1960s accelerated economic growth, while value added production and technology investments contributed to growth rates in the 1970s and 1980s. However, events such as the financial crises in 1997 and 2008 and the COVID-19 pandemic in 2020 led to sharp declines in the economy. In 2021, Singapore achieved a growth rate of 8.88%, increasing its GDP to USD 466.79 billion in 2022. However, growth slowed to 1.2% in 2023 due to the global economic slowdown and anti-inflation policies (IMF estimates). In 2022 and 2023, the manufacturing sector remained under pressure due to the global demand contraction and shortages in the semiconductor industry, while geopolitical uncertainties such as the US-China chip war also had a negative impact. However, rising demand for artificial intelligence and the expansion of chipmakers provide a positive outlook for 2024. In 2022, Singapore's GDP per capita ranked 10th globally at USD 82,807.6 (World Bank Doing Business, 2020). In the third quarter of 2023, the unemployment rate remained stable at 1.9% overall and 2.9% for citizens. Employment rates increased, especially for older workers and returning women, indicating the development of an inclusive labor market. Despite the increase in incomes, real incomes have come under pressure due to inflation and government transfers have played a role in mitigating this effect (Ministry of Manpower Singapore, 2023). In terms of foreign trade, Singapore's largest export item in 2022 was "Machinery and Transportation Equipment", accounting for 63.1% of total exports. In addition, "Chemicals and Chemical Products" and "Other Manufacturing Products" are also among the important export items (Ministry of Trade and Industry, 2024). In monetary policy, the Monetary Authority of Singapore (MAS) has adopted an exchange rate oriented policy to control the value of the Singapore dollar and inflation. In 2022, inflation rose to 6.1% and cost increases were observed, especially in items such as transportation, food, housing and utilities. MAS continues to adjust monetary policy to mitigate these pressures (SingStat, 2023; MAS, 2022).

5.8. Singapore in Selected Reports

At present, Singapore is recognized as one of the world's most competitive economies, home to global businesses and a leader in various sectors. According to the World Bank's "Doing Business 2020" report, Singapore ranks 2nd among 190 economies in terms of ease of doing business and encourages multinational companies to invest with its strong regulatory environment (World Bank Doing Business, 2020; Singapore Economic Development Board, 2023). Singapore's housing policies have made significant contributions to social structure. While only 20% of the population lived in public housing in the 1960s, today this rate is over 80%. In 2022, 23,800 new apartments were completed and more than 21,200 homes were delivered. This program has successfully met the housing needs of low and middle income citizens (Hirschl, 2020; Housing and Development Board, 2022/2023). Singapore has also made significant achievements in globalization and economic integration, ranking first in

economic integration and seventh in social globalization according to the KOF Globalization Index (KOF Globalization Index, 2023). Concerning income inequality, the Gini coefficient decreased from 0.437 before the government intervention to 0.378 after the intervention, which shows the effectiveness of government policies in reducing income inequality (Key Household Income Trends Report, 2022). Singapore ranked first as the world's freest economy in the 2023 Index of Economic Freedom, notable for its competitive tax rates and transparent regulatory environment (The Heritage Foundation, 2023). In addition, it stands out as the fourth most competitive economy in the world as of 2023 in the IMD World Competitiveness Ranking (IMD World Competitiveness Ranking, 2023).

6. Green Growth in Singapore

Singapore pursues a green growth strategy that balances economic development with environmental sustainability. As described in detail in the previous sections, Green growth aims to minimize the environmental impact of economic activities and use natural resources sustainably (Bowen, 2012; Yalçın, 2016). Initiatives such as the "Green Plan 2030", Singapore promotes sustainable urbanism and energy policies and aims to integrate environmental sustainability and economic growth. These plans aim to realize the country's goal of creating a liveable environment for future generations while maintaining its competitiveness in the global economy. Singapore's green growth strategies are guided by the "Singapore Green Plan 2030" and the "Long Term Low Emission Development Strategy" (LEDS), with the goal of achieving net zero emissions by 2050. These initiatives align with the UN's 2030 Agenda for Sustainable Development and the Paris Agreement. Although Singapore contributes only 0.1% to global emissions, it has committed to reducing emissions to 60 MtCO2e by 2030 and achieving net zero by 2050, consistent with the Glasgow Climate Pact signed at COP-26 in 2021 (Singapore National Climate Change Secretariat, 2024).

6.1. Singapore Green Plan 2030

Singapore's vision of a "Garden City" began in 1967, emphasizing a clean and green environment, followed by initiatives like the Singapore Green Plan in the late 1980s and the "Blue Plan for a Sustainable Singapore" in 2009. The "Green Plan 2030," announced in 2021, aims to advance Singapore's sustainability goals (National Library Board Singapore, 2024). This comprehensive strategy targets net zero emissions by 2050, aligning with the Paris Agreement and the 2030 Agenda for Sustainable Development. Despite contributing only 0.1% to global emissions, Singapore is committed to sustainability leadership. The Green Plan 2030 is based on five key pillars: City in Nature, Energy Reset, Green Economy, Resilient Future, and Sustainable Living. The "City in Nature" initiative focuses on expanding nature parks and green infrastructure to bolster urban sustainability amid climate change. "Energy Reset" aims to boost solar energy capacity, expand energy storage systems, and integrate with regional grids, targeting 2 GW of peak power by 2030 to meet the needs of 350,000 households. The "Green Economy" strategy includes decarbonizing industries, developing new green industries and preparing the workforce for this new economy. Incentives such as the Energy Efficiency Grant support the sustainability of industries, and initiatives such as the RIE2025 program invest in low carbon technologies. In addition, Singapore has taken the lead in Southeast Asia by introducing a carbon tax in 2019 and aims to raise it to S$25/tCO2e in 2024-2025 and to a range of S$50-80/tCO2e by 2030. The "Resilient Future" pillar includes measures against sea level rise and targets to meet 30% of food needs through local production by 2030. "Sustainable Living" aims to reduce carbon emissions, adopt circular economy principles and increase environmental sustainability in transportation by expanding the rail network.

6.2. Singapore's Green Transition Financing Efforts

As part of its green transformation goals, Singapore aims to become a major hub for carbon trading and decarbonisation finance. In 2022, the global carbon credit market was worth $978.56 billion and is expected to reach $2.68 trillion by 2028 (Daedal Research, 2023). Singapore is home to the regional headquarters of more than 70 international companies in this field, and this sector is expected to contribute USD 1.8 to 5.6 billion to the economy by 2050. Singapore also supports carbon market development by establishing the International Advisory Panel for Carbon Credits (IAPCC) (National Environment Agency, 2023). Singapore aims to be a leader in the carbon market and trading with its "Emerging Stronger Together" initiative, and aims to provide high quality carbon credits through its new carbon exchange, Climate Impact X (CIX) (Economic Development Board, 2023). In addition, Singapore has signed several Memorandums of Understanding (MoUs) for carbon tax credits, making it easier to realize national contribution declarations (National Climate Change Secretariat, 2024). Singapore is investing $220 million in resource circularity and water technologies under the RIE2025 program. This effort promotes environmental research and focuses on issues such as waste management and pollution control (Research, Innovation and Enterprise 2025 Handbook, 2020).

The Enterprise Sustainability Program (ESP) specifically supports SMEs to integrate into the green economy, while the Enterprise Financing Scheme - Green provides financing to support growth in areas such as green energy and circular economy (Enterprise Singapore, 2024). The EDGE Program is a $20 million research program to develop Singapore's energy engineering capabilities and aims to develop innovations in energy technologies (Energy Market Authority, 2023). The Monetary Authority of Singapore (MAS) aims to provide financing to support the transition to carbon neutrality through the NetZero Financing Action Plan (Monetary Authority of Singapore, 2023). The Singapore Green Finance Center (SGFC) and the Sustainable and Green Finance

Institute (SGFIN) are working to promote sustainable investment in Asia and position Singapore as a hub for green finance. These initiatives aim to provide Asia focused thought leadership in tackling climate change (Singapore Green Finance Centre, 2024). Singapore is developing strategies to counter sea level rise, improve food security and mitigate the urban heat island effect. The"30 by 30 " target aims to meet 30% of its food needs with local production by 2030. Singapore supports environmental sustainability with the principle of "Reduce, Reuse, Recycle" and aims to reduce carbon emissions by expanding rail and bicycle lanes.

6.3. National Contribution Declaration (NDC) and Long-term Low Emission Development Strategy (LEDS)

Singapore commits to achieve a net zero emissions target by 2050 through its updated 2030 Nationally Determined Contribution (NDC) and Long Term Low Emission Development Strategy (LEDS) submitted to the United Nations Framework Convention on Climate Change (UNFCCC) (Singapore National Climate Change Secretariat, 2024). The NDCs are a continuation of the National Appropriate Mitigation Action (NAMA) process, which started in 2009 and aims for GHG emission intensity 16% below 2020 levels. In 2015, this target was made clearer and 65 MtCO2e emissions were targeted by 2030 with a 36% reduction in emission intensity compared to 2005. Under the Long Term Low Emission Development Strategy (LEDS), Singapore has adopted climate strategies like sustainable transportation, green buildings, waste and water management, and urban greening. Specific measures include capping private car growth and phasing out internal combustion engine vehicles by 2040. Key components of the low carbon strategy include energy efficiency, carbon capture, low carbon hydrogen, and international carbon markets. Singapore aims to increase international cooperation and position itself as a carbon trading hub, contributing through the International Advisory Panel on Carbon Credits (IAPCC) and implementing policies like carbon tax and energy conservation (Geels et al., 2017). Community engagement and education are also crucial, with initiatives like "Youth for Environment Day" promoting environmental awareness. Singapore also supports international collaboration, particularly through South-South and Trilateral Cooperation, to assist developing countries in achieving common sustainability solutions.

6.4. Singapore's Approach to Achieving Sustainable Development Goals

Singapore has adopted a comprehensive approach to achieving the Sustainable Development Goals (SDGs), focusing on inclusivity and eradicating poverty (Goal 1: End Poverty) through support programs for low-income and vulnerable groups and workforce skill enhancement (Ministry of Foreign Affairs Singapore, 2023; UNSDG, 2023). Despite limited agricultural land, the country aims to meet 30% of its nutritional needs locally by 2030 to enhance food security (Goal 2: Zero Hunger). To promote health (Goal 3: Health and Quality of Life), Singapore has implemented high living standards, universal health insurance, and digitalized healthcare, also addressing the needs of an aging population and managing infectious diseases. For education (Goal 4: Quality Education), Singapore has established an inclusive and equitable system, ensuring flexible structures to accommodate diverse student needs. Providing lifelong learning opportunities and improving teacher quality are also important elements of this goal. In order to achieve gender equality (Goal 5: Gender Equality), legal reforms and social initiatives that strengthen women's rights are carried out to increase women's leadership and economic empowerment (Ministry of Foreign Affairs Singapore, 2023). On clean water and sanitation, Singapore has adopted an innovative water management strategy and developed the Four National Taps strategy to diversify water sources, including local water, imported water, NEWater and desalination (Goal 6: Clean Water and Sanitation).

In energy, the country is increasing the use of natural gas instead of oil and investing in the use of solar energy to support the transition to clean energy (Goal 7: Affordable and Clean Energy). There are also plans to develop regional electricity networks, with the goal of importing low carbon electricity by 2035. In line with the goal of achieving economic growth and quality employment (Goal 8: Decent Work and Economic Growth), Singapore has adopted green economy strategies for sustainable growth and developed support policies to enhance the resilience of the economy during the COVID-19 period. By promoting sustainable industrial practices and innovation (Goal 9: Industry, Innovation and Infrastructure), it contributes to economic growth and supports industrial transformation through investments in green technology and infrastructure. To reduce inequalities (Goal 10: Reducing Inequalities), policies such as the Wage Model for low income workers were developed, and the social security system and access to early childhood education were improved. To create sustainable and livable cities (Goal 11: Sustainable Cities and Communities), Singapore strives to make society more resilient through improved urban planning and green infrastructure. Transportation, housing and landscaping are important components of these efforts. At the same time, to achieve responsible consumption and production goals (Goal 12: Responsible Consumption and Production), it promotes recycling and efficient use of resources through the Zero Waste Master Plan and Resource Sustainability Act, which aim to increase waste management and recycling rates (Ministry of Foreign Affairs Singapore, 2023; UNSDG, 2023).

In the fight against climate change (Goal 13: Climate Action), Singapore has developed carbon tax, transition to renewable energy and sustainable transportation strategies, and has implemented the Singapore Green Plan 2030 in this context. Adopting the principles of Integrated Urban Coastal Management for the protection of marine and terrestrial ecosystems (Goal 14: Life in Water, Goal 15: Life on Land),

the country pursues the “City in a Garden” vision to increase biodiversity and expand urban green spaces. Initiatives such as the One Million Trees Campaign encourage public participation in protecting green spaces. Building a strong framework for peace and justice with a zero tolerance policy on corruption and transparent, accountable public institutions, Singapore places great importance on international cooperation to achieve the global sustainable development goals (Goal 16: Peace, Justice and Strong Institutions). Through the Singapore Cooperation Program (SCP), it contributes to global cooperation by sharing development experiences with more than 180 countries (Goal 17: Partnerships for Goals).

6.5. Singapore's Developmental State and Developmental Leader Policies

Lastly, the developmental leader, which is an important factor for Singapore's success in its developmental journey, is worth a mention. Together with the developmental leader, the developmental state will also be mentioned. Development economics literature has emphasized the role of the state and leaders in Singapore's development process. Behind Singapore's success lies the state's ability to develop and implement strategic industrialization policies. While industrialization often fails in countries where the developmental state structure is lacking, Singapore has built this structure and succeeded in joining the global competition. The concept of the developmental state was first defined by Johnson (1982) and defined as the state allocating resources to specific sectors by taking strategic measures for industrialization. The economic success of Asian countries has formed the basis of this concept. Krugman (1994) saw Asia's economic growth not as a “miracle” but as a growth based on an increase in resources and characterized these achievements as “paper tigers”. In contrast, mainstream approaches such as the World Bank attributed this growth to the efficient functioning of free market mechanisms. The developmental state approach, however, argued that Asia's success was based on strategic state intervention. Underlying the success of developmental states is “embedded autonomy”, which refers to the capacity to establish an effective relationship with the private sector while at the same time keeping it free from negative influences such as corruption. Meritocratic bureaucracy plays a crucial role in developing long-term, research-based policies, while developmental leaders are vital for driving transformation under complex socioeconomic conditions (Yülek and Akkemik, 2022).

Lee Kuan Yew, Singapore's founding leader, exemplified this leadership style, transforming the nation from a low-income economy to a high-income global trade hub. Lee emphasized foreign investment, long-term planning, education, and infrastructure, supported by a strong, autonomous state structure. His approach, often characterized as authoritarian, underscores the importance of state intervention and strategic industrialization in achieving development goals. The developmental state and leadership frameworks are key to understanding Singapore's transformation and Asia's broader economic successes, showing how effective strategic state intervention can drive economic growth (Yülek and Akkemik, 2022; Yusof et al., 2023; Mechitov et al., 2021).

Conclusion

In summary, Singapore's transformation from a small island economy to a leader in green growth and sustainable development presents an essential paradigm. This study demonstrates that integrating economic growth with environmental sustainability is both feasible and beneficial. It provides a valuable contribution to academic and policy discourse by detailing Singapore's industrial and green policies for fostering a sustainable economy. The experience underscores the critical role of government and visionary leadership in navigating the challenges of sustainable development. The case study illustrates that targeted government policies promoting green growth and industrial innovation can yield substantial environmental and economic gains. By combining development leadership with a clear strategic vision, Singapore has set a benchmark for other economies seeking to follow a similar sustainable growth path. Recognized as one of the successful Asian Tigers of the 1980s, Singapore is well known for its successful development journey. Today, green transformation is a hot topic and offers significant opportunities, and Singapore, as an example of this successful development journey, is taking very important steps towards green transformation. Analysis of Singapore's green growth strategies, particularly the Green Plan and its participation in the carbon credit market, provides compelling evidence of the effectiveness of integrated policy approaches. These strategies contribute to global environmental goals while enhancing national competitiveness and social welfare. This multi pronged approach to development, balancing economic, environmental and social objectives, is a testament to the foresight and adaptability of Singapore's policy framework.

The paper highlights the crucial role of industrial policies that foster sustainable and green growth, contributing meaningfully to the global dialogue on sustainable development strategies. Singapore’s policy innovations offer valuable insights into the feasibility and benefits of a green growth agenda, particularly for developing nations. As the world confronts the challenges of climate change and sustainable development, the Singapore model serves as an example of how strategic policy formulation can achieve positive environmental and economic results. Singapore's experience provides a roadmap for embedding sustainability in economic policy, emphasizing the importance of a coherent strategy that addresses modern development complexities in an interconnected world. However, while green policies present significant opportunities for developing countries, they also pose risks. For example, the rising market value of carbon credits may contribute to new income inequalities, creating a potential risk for equitable sustainable

development. Future research must focus on designing green growth strategies that yield fair economic outcomes, ensuring that the benefits are widely shared and that inequalities are not exacerbated. This requires exploring innovative financing models and integrating social equity into green policy design, making it essential for achieving truly sustainable development.

References

Aghion, P., and Howitt, P. (1992). A model of growth through creative destruction. Econometrica, 60(2), 323–351. https://doi.org/10.2307/2951599

Aiginger, K., and Rodrik, D. (2020). Rebirth of industrial policy and an agenda for the twenty-first century. Journal of Industry, Competition and Trade. https://tinyurl.com/y82ujas5

Aksu, L. (2018). İktisadi büyüme, iktisat okullarının bakış açısı ve Türkiye. IKSAD Publications.

Alacevich, M., and Boianovsky, M. (Eds.). (2018). The political economy of development economics: A historical perspective (Supplement). History of Political Economy.

Allan, B., Lewis, J. I., and Oatley, T. (2021). Green industrial policy and the global transformation of climate politics. Global Environmental Politics, 21(4), 1-19.

Ambroziak, A. A. (2017). Review of the literature on the theory of industrial policy. In The new industrial policy of the European Union (pp. 3-38). Springer.

Arlı Yılmaz, S. (2014). Yeşil işler ve Türkiye'de yenilenebilir enerji alanındaki potansiyeli: Uzmanlık tezi (Seri No. 2887). T.C. Kalkınma Bakanlığı.

Lütkenhorst, W., Vidican, G., Altenburg, T., and Pegels, A. (2014). Green industrial policy. Managing transformation under uncertainty. *Discussion Paper, No. 28/2014*. https://www.econstor.eu/bitstream/10419/199441/1/die-dp-2014-28.pdf

WWF. (2022). *Living planet report 2022. Building a nature positive society* (R. E. A. Almond, M. Grooten, D. Juffe Bignoli, and T. Petersen, Eds.). WWF.

Hansen, J., Ruedy, R., Sato, M., and Lo, K. (2010). Global surface temperature change.

Hák, T., Janoušková, S., and Moldan, B. (2016). Sustainable development goals: A need for relevant indicators. *Ecological Indicators, 60*, 565-573. https://doi.org/10.1016/j.ecolind.2015.08.003

United Nations. (2023). *The sustainable development goals report 2023: Special edition - Towards a rescue plan for people and planet*. United Nations.

Claeys, G., Demertzis, M., and Papadia, F. (2019). Challenges ahead for the European Central Bank: Navigating in the dark? *Monetary Dialogue, September 2019*. Bruegel. Taxation and Customs Union. (2023). Carbon border adjustment mechanism. *European Commission*. https://taxation-customs.ec.europa.eu/carbon-border-adjustmentmechanism_en

Borel Saladin, J. M., and Turok, I. N. (2013). The green economy: Incremental change or transformation? Environmental Policy and Governance, 23, 209-220. https://doi.org/10.1002/eet.1614

Bowen, A. (2012). Green growth: What does it mean? The Grantham Research Institute on Climate Change and the Environment, the London School of Economics and Political Science. https://www.lse.ac.uk/GranthamInstitute/wpcontent/uploads/2014/02/green-growth-environmental-scientist-dec12.pdf

Daedal Research. (2023). Global carbon credit market: Analysis by traded value, traded volume, segment, project category, region, size and trends with impact of COVID-19 and forecast up to 2028. https://www.researchandmarkets.com/reports/5774731/global-carbon-credit-market-analysis-traded

Denison, E. F. (1962). The sources of economic growth in the United States and the alternatives before us. Committee for Economic Development.

Dutta, S., Leon, L., and Wunsch-Vincen, S. (Eds.). (2023). Global innovation index 2023. www.wipo.int. https://doi.org/10.34667/tind.46596

Energy Market Authority. (2023). Collaborations: Singapore Institute of Technology. https://www.ema.gov.sg/partnerships/research-and-developmentengagements/collaborations/singapore-institute-of-technology

Feldman, M., Hadjimichael, T., Lanahan, L., and Kemeny, T. (2016). The logic of economic development: A definition and model for investment. Environment and Planning C: Government and Policy, 34(1), 5-21. https://doi.org/10.1177/0263774X15614653

Fetting, C. (2020). The European green deal. ESDN Report, December 2020. ESDN Office.

Frenken, K., and Boschma, R. A. (2007). A theoretical framework for evolutionary economic geography: Industrial dynamics and urban growth as a branching process. Journal of Economic Geography, 7(5), 635–649. http://www.jstor.org/stable/26161121

Geels, F. W., Sovacool, B. K., Schwanen, T., and Sorrell, S. (2017). The socio-technical dynamics of low-carbon transitions. Joule, 1(3), 463-479. https://doi.org/10.1016/j.joule.2017.09.018

Greenlaw, S. A., and Shapiro, D. (2017). Principles of microeconomics 2e. OpenStax. https://openstax.org/books/principles-microeconomics-2e/pages/1-introduction

Greenwald, B., and Stiglitz, J. E. (1987). Keynesian, New Keynesian, and New Classical economics. Oxford Economic Papers, 39(1), 119-133. https://www.jstor.org/stable/2663132

Hartwell, R. M. (1990). Was there an industrial revolution? Social Science History, 14(4), 567–576. https://doi.org/10.2307/1171333

Johnson, C. (1982). MITI and the Japanese miracle: The growth of industrial policy, 1925-1975 (1st ed.). Stanford University Press.

Kose, M. A., Prasad, E., Rogoff, K., and Wei, S.-J. (2010). Financial globalization and economic policies. In D. Rodrik and M. Rosenzweig (Eds.), Handbook of development economics (Vol. 5, pp. 4283-4359). Elsevier. https://doi.org/10.1016/B978-0-444-52944-2.00003-3

Krugman, P. (1994). The myth of Asia's miracle. Foreign Affairs, 73(6), 62-78.

Kuşat, N. (2013). Yeşil sürdürülebilirlik için yeşil ekonomi: Avantaj ve dezavantajları – Türkiye incelemesi. Yaşar Üniversitesi E-Dergisi, 8(29), 4896-4916. https://doi.org/10.19168/jyu.81368

Kuznets, S. (1955). Economic growth and income inequality. American Economic Review, 45(1), 1-28.

Lee Hsien Loong. (2011, October 24). Transcript of PM's speech for debate on the president's address (Document Number: 20111031008). Singapore. Ministry of Information, Communications and the Arts.

Loiseau, E., Saikku, L., Antikainen, R., Droste, N., Hansjürgens, B., Pitkänen, K., Thomsen, M., et al. (2016). Green economy and related concepts: An overview. Journal of Cleaner Production, 139, 361-371.

Lucas, R. E. (1988). On the mechanics of economic development. Journal of Monetary Economics, 22(3), 36-42.

MAS. (2023). Monetary Authority of Singapore. https://www.mas.gov.sg/

Mechitov, A. I., Moshkovich, H. M., and Grainger, M. (2021). Lee Kuan Yew's leadership lessons from developing Singapore. International Journal of Business Strategy, 21(1), 42-51.

Ministry of Foreign Affairs and Trade and the New Zealand Government. (2023, August). ASEAN: Regional economic outlook market intelligence report. https://www.mfat.govt.nz/market-reports

Ministry of Foreign Affairs Singapore. (2023). Voluntary national reviews 2023. www.mfa.gov.sg. https://www.mfa.gov.sg/SINGAPORES-FOREIGN-POLICY/International-Issues/Singapore-Voluntary-National-Review

Ministry of Foreign Affairs. (n.d.). Singapur siyasi görünümü. https://www.mfa.gov.tr/sub.tr.mfa?4fa9f9c9-e9e5-49b5-8592-8b869762ccb8

Ministry of Trade and Industry. (2024, January 2). Singapore Gross Domestic Product (GDP) fourth quarter 2023. https://www.singstat.gov.sg/-/media/files/news/advgdp4q2023.ashx

Singapore Economic Development Board. (n.d.). Singapore's economic development. https://www.edb.gov.sg/en/our-industries/economic-overview/singaporeseconomic-development.html

Ministry of Education Singapore. (2019, December 3). Singapore students show well-developed thinking and reasoning skills: OECD PISA 2018 study. https://www.moe.gov.sg/news/press-releases/20191203-singapore-students-showwell-developed-thinking-and-reasoning-skills-oecd-pisa-2018-study

World Economic Forum. (2015, April 22). Is education the secret to Singapore's success? https://www.weforum.org/agenda/2015/04/is-education-the-secret-to-singaporessuccess/

Kozma, R. (2011). Transforming education: The power of ICT policies. UNESCO Institute for Information Technologies in Education. https://unesdoc.unesco.org/ark:/48223/pf0000211842

Ferris, S. P., and Waldron, K. (2023). The educational system in Singapore. In S. P. Ferris and K. Waldron (Eds.), *Thriving in academic leadership (Surviving and thriving in academia)* (pp. 125-127). Emerald Publishing Limited. https://doi.org/10.1108/978-1-83753-300-820231014

Ministry of Education, Singapore. (2024). *Overview of Singapore education system*. Ministry of Education, Singapore. https://www.moe.gov.sg/-/media/files/aboutus/overview_of_singapore_education_system.pdf

Maradana, R. P., Pradhan, R. P., Dash, S., et al. (2017). Does innovation promote economic growth? Evidence from European countries. *Journal of Innovation and Entrepreneurship*, *6*(1). https://doi.org/10.1186/s13731-016-0061-9

Intellectual Property Office of Singapore. (2021). *Singapore IP strategy report 2030*. https://www.ipos.gov.sg/docs/default-source/default-document-library/singaporeip-strategy-report-2030-18May2021.pdf

World Intellectual Property Organization. (2024). Innovation and intellectual property. https://www.wipo.int/ip-outreach/en/ipday/2017/innovation_and_intellectual_property.html

Ministry of Manpower Singapore. (2023). *Labour market report third quarter 2023*. https://www.mom.gov.sg/newsroom/press-releases/2023/1214-labour-marketreport-third-quarter-2023#:~:text=The%20labour%20market%20expanded%20in,increase%20was%20in%20growth%20sectors

Singstat. (2023). Economy. https://www.singstat.gov.sg/find-data/searchby-theme?theme=economyandtype=data

MAS. (2022). Monetary Authority of Singapore. https://www.mas.gov.sg/

Doing Business 2020. (2020). World Bank. https://documents1.worldbank.org/curated/en/688761571934946384/pdf/Doing-Business-2020-Comparing-BusinessRegulation-in-190-Economies.pdf

Hirschl, R. (2020). *City, state: Constitutionalism and the megacity*. Oxford University Press.
Housing and Development Board. (2022/2023). About HDB. https://www.hdb.gov.sg/cs/infoweb/homepage
KOF Globalisation Index. (2023, June 12). *KOF globalisation index – KOF Swiss Economic Institute | ETH Zurich*. https://kof.ethz.ch/en/forecasts-and-indicators/indicators/kofglobalisation-index.html

Singapore Department of Statistics. (2022, January 14). Advance estimate of gross domestic product for 4th quarter 2022. https://www.singstat.gov.sg/-/media/files/news/gdp4q2022.ashx

International Institute for Management Development (IMD). (2023). *World competitiveness ranking*. IMD World Competitiveness Center. https://www.imd.org/centers/wcc/world-competitiveness-center/rankings/world-competitiveness-ranking/

Singapore National Climate Change Secretariat. (2024). www.nccs.gov.sg. https://www.nccs.gov.sg/singapores-climate-action/singapore-and-internationalefforts/

National Library Board Singapore. (2023). www.nlb.gov.sg. https://www.nlb.gov.sg/main/article-detail?cmsuuid=f4e013e3-bdf0-4590-a80b-7533a4c7ffc0

National Environment Agency. (2023, October 4). Singapore sets out eligibility criteria for international carbon credits under the carbon tax regime. https://www.nea.gov.sg/media/news/news/index/singapore-sets-out-eligibilitycriteria-for-international-carbon-credits-under-the-carbon-tax-regime

Mun Heng, T. (2015). Singapore's economic development in the light of modern development concepts. In Economic planning and industrial policy in the globalizing economy: Concepts, experience and prospects (pp. 125-147).

Petrashko, L. (2017). Industrial policy for a sustainable growth path in Ukraine. In M. Yülek (Ed.), Industrial policy and sustainable growth (pp. 11-1). Springer. https://doi.org/10.1007/978-981-10-3964-5_11-1

Rebelo, S. (1991). Long-run policy analysis and long-run growth. Journal of Political Economy, 99(3), 500–521. http://www.jstor.org/stable/2937740

Research, Innovation and Enterprise (RIE). (2020). 2025 handbook. https://www.nrf.gov.sg/rie-ecosystem/rie2025handbook/

Rodrik, D. (2014). Green industrial policy. Oxford Review of Economic Policy, 30(3), 469–491. https://drodrik.scholar.harvard.edu/files/dani-rodrik/files/green_industrial_policy.pdf

Romer, P. M. (1986). Increasing returns and long-run growth. Journal of Political Economy, 94(5), 1002-1037. University of Chicago Press.

Rostow, W. W. (1960). The stages of economic growth: A non-communist manifesto. Cambridge University Press.

Rowthorn, R., and Wells, J. (1987). Deindustrialization and foreign trade. Cambridge University Press.

Shackleton, J. R. (2013). Introduction. Economic Affairs, 33(2), 155-155. Wiley Blackwell.

Solow, R. M. (1956). A contribution to the theory of economic growth. The Quarterly Journal of Economics, 70(1), 65-94. http://www.jstor.org/stable/1884513

Spencer, D. (2009). The political economy of work (1st ed.).

Tagliapietra, S., and Veugelers, R. (2020). A green industrial policy for Europe (Blueprint Series 31). In S. Gardner (Ed.), Bruegel Blueprint Series. Bruegel.

Taylor, J. E., and Lybbert, T. J. (2020). Essentials of development economics, third edition (3rd ed.). University of California Press. https://doi.org/10.2307/j.ctv1503ghb

UNEP. (2011). Towards a green economy: Pathways to sustainable development and poverty eradication. http://web.unep.org/greeneconomy/sites/unep.org.greeneconomy/files/field/image/green_economyreport_final_dec2011.pdf

United Nations Development Programme. (2018). Human development reports. http://hdr.undp.org/en/countries/profiles/ZMB

United Nations Development Programme. (2023). Global Knowledge Index 2023. https://knowledge4all.com/admin/2023/Methodology/GKI2023_Report_EN.pdf

United Nations Environment Programme. (2014). UNEP year book: Emerging issues in our global environment.

United Nations Industrial Development Organization. (2023). UNIDO industrial statistics yearbook 2023. https://www.unido.org/sites/default/files/unido-publications/2023-12/UNIDO_IndustrialStatistics_Yearbook_2023.pdf

UNSDG. (2023). https://unstats.un.org/sdgs/dataportal/countryprofiles/SGP

Yusof, A. M. M., Jaes, L., and Razali, N. A. (2023). Paternalistic leadership Lee Kuan Yew on Singapore developmental state. AIP Conference Proceedings, 2827(1), 030022.

Yülek, M. (1991). Singapur. Devlet Planlama Teşkilat Yayını.

Yülek, M. (1998). Asya kaplanları: Sanayi politikaları ve kalkınma. Alfa Yayınları.

Yülek, M. (2018). How nations succeed: Manufacturing, trade, industrial policy, and economic development. Palgrave MacMillan.

Yülek, M. A. (2017). On the middle income trap, the industrialization process and appropriate industrial policy. Journal of Industry, Competition and Trade, 17, 325-348.

Yülek, M. A., and Akkemik, K. A. (2022). The developmental leader. Asia Pacific Economic Literature, 36, 3-16. https://doi.org/10.1111/apel.12364

Yülek, M., and Gür, N. (2017). Foreign direct investment, smart policies, and economic growth. Progress in Development Studies, 17(3), 1–12.
https://doi.org/10.1177/1464993417713272

INDUSTRIAL POLICY
A Scientific Journal Dedicated to Economic Development and Industrial Policy

OPEN ACCESS

Review Article

www.indpol.org

DOI: 10.61192/indpol.1530890

IndPol, 2024; 4(2): 90-99

As a Public Diplomacy Component Technology Management Policy and Technology Transfer Offices of Turkey

Süleyman Turgut
Technology Transfer Office, OSTİM Technical University, Ankara, Türkiye, ORCID: 0000-0003-1466-402X

Abstract

This study examines the intersection of Turkey's National Technology Management Policy and its public diplomacy initiatives, highlighting the critical role of technological advancement in shaping the country's international influence and soft power. Public diplomacy, defined as a multifaceted instrument for managing relationships and influencing foreign public opinion, has evolved to encompass various strategies aimed at promoting national interests and values. The integration of Science, Technology, and Innovation (STI) policies within Turkey's national development framework is essential for enhancing its technological capabilities and competitiveness on the global stage. The establishment of Technology Transfer Offices (TTOs) in Turkish universities serves as a pivotal mechanism for facilitating the transfer of knowledge and technology between academia and industry, thereby stimulating innovation and economic growth. This relationship underscores the broader impact of TTOs on Turkey's innovation ecosystem and their contribution to public diplomacy by showcasing the nation's advancements in technology. Furthermore, Turkey's centralized approach to policy formulation and its strategic response to global challenges, such as the COVID-19 pandemic, illustrate the effective coordination of technology management and public diplomacy efforts. Overall, this analysis emphasizes that Turkey's commitment to integrating technology management policies within its public diplomacy framework is a vital strategy for enhancing its international reputation and influence. By leveraging its technological advancements, Turkey can effectively promote its values and foster collaboration with other nations, thereby solidifying its position as a key player in the global arena.

Article History
Received August 9, 2024
Revised October 22, 2024
Accepted October 24, 2024

Keywords
Technology Management Policy, Technology Transfer Offices, Public Diplomacy, International Image, Soft Power, Innovation

JEL Codes
O21, O25

1. Introduction

Public diplomacy has emerged as a critical instrument for states seeking to enhance their international standing and influence through the strategic management of cultural and political communication. Defined as a multifaceted approach to understanding and influencing foreign public opinion, public diplomacy encompasses a range of activities aimed at advancing national interests and values on the global stage. It serves as a vital component of soft power, enabling countries to cultivate relationships, shape perceptions, and mobilize actions that align with their foreign policy objectives. The evolution of public diplomacy reflects the increasing importance of cultural engagement and strategic communication in international relations, highlighting its role in fostering mutual understanding and cooperation among nations. In the context of Turkey, the National Technology Management Policy plays a significant role in shaping the

CONTACT Süleyman Turgut suleyman.turgut@ostimteknik.edu.tr

country's public diplomacy efforts. This policy framework is designed to promote the production, diffusion, and application of scientific and technological knowledge, aligning with national goals and enhancing Turkey's technological capabilities. The integration of Science, Technology, and Innovation (STI) policies within national development planning not only fosters innovation but also contributes to Turkey's international reputation, particularly in sectors such as healthcare and technology. For instance, the adoption of electronic health records in Turkish hospitals has been highlighted as a technological advancement that enhances Turkey's public diplomacy by showcasing its achievements in healthcare technology. Moreover, the establishment of Technology Transfer Offices (TTOs) in Turkish universities underscores the strategic importance of technology transfer initiatives in stimulating innovation and economic development. TTOs facilitate the transfer of knowledge and technologies between academia and industry, thereby contributing to the country's competitiveness and technological advancement. This relationship between technology management and public diplomacy is crucial, as it enables Turkey to leverage its technological capabilities to enhance its international image and influence. By effectively managing its technological resources and promoting its innovations, Turkey can strengthen its public diplomacy efforts and position itself as a key player in the global arena. In summary, public diplomacy serves as a vital tool for states like Turkey to advance their interests and values internationally. The interplay between technology management policies and public diplomacy initiatives highlights the importance of fostering innovation and showcasing technological achievements as a means of enhancing a country's global standing. As nations navigate the complexities of international relations, the strategic integration of technology and public diplomacy will continue to play a pivotal role in shaping their influence and reputation on the world stage.

2. Public Diplomacy & National Technology Management Policy

Public diplomacy is a multifaceted instrument used by states, associations of states, and various actors to understand cultures, attitudes, and behavior, manage relationships, and influence opinions and actions to advance their interests and values (White, 2015). It involves the management of international political communication in accordance with the interests of foreign action and policy (Manfredi-Sánchez, 2022). Public diplomacy is also considered as one of the most important elements of soft power that states use to promote their values and ideas (Namuq & Al-BAYATI, 2021). It encompasses activities undertaken by a national government to inform and influence foreign public opinion and attitudes in order to advance its foreign policy goals (Mazumdar, 2020). The concept of public diplomacy has evolved over time. Initially, it was defined as the cultivation of foreign public opinion by governments (Pavón-Guinea, 2023). However, it has now come to mean an instrument used to build and manage relationships, understand cultures, influence thoughts, and mobilize actions to advance interests and values (Doncel-Martín et al., 2022). This evolution reflects the changing nature of international relations and the increasing importance of soft power and cultural diplomacy in shaping foreign policy. Public diplomacy is closely related to the concept of soft power, which emphasizes the ability to persuade and create reputation, as well as cultural and institutional attractiveness. It involves the use of various tools, including corporate social responsibility, digital diplomacy, and cultural exchange programs, to enhance a country's international standing and influence. Furthermore, public diplomacy is no longer a separate instrument of diplomacy but is deeply intertwined with other dimensions of international relations, such as cultural diplomacy and soft power. In practice, public diplomacy takes various forms, such as educational policies, cultural exchange programs, and diplomatic gifts, all aimed at fostering goodwill and enhancing a country's image abroad. It also involves engaging with foreign societies and governments to build mutual understanding and trust, thereby contributing to the overall objectives of foreign policy. In conclusion, public diplomacy is a dynamic and essential component of contemporary international relations, encompassing a wide range of activities aimed at influencing foreign public opinion, building relationships, and advancing a country's interests and values on the global stage.

The National Technology Management Policy refers to the public policies implemented by governments to promote the production, diffusion, and application of scientific and technological knowledge to achieve national goals (Jia et al., 2020). It encompasses a set of decisions taken by a government, through appropriate laws and regulations, to orient the harmonious development of information transfer activities to satisfy the information needs of a country (Alemna, 1999). Additionally, the integration of Science, Technology, and Innovation (STI) policy within the overall framework of national development planning is crucial for the advancement of a country's technological capabilities (Oladeji & Adegboye, 2019). These policies are designed to foster innovation, research, and development within a country, aiming to enhance its technological capabilities and competitiveness on the global stage. They also play a significant role in shaping the direction of technological progress and its integration into the broader national development agenda. In conclusion, the National Technology Management Policy is a strategic framework that guides a country's approach to science, technology, and innovation, with the aim of achieving national development goals and enhancing its technological capacity.

The relationship between Technology Management Policy and Public Diplomacy is multifaceted and interconnected. Technology Management Policy, which encompasses the public policies implemented by governments to promote the production, diffusion, and application of scientific and

technological knowledge to achieve national goals, plays a crucial role in shaping a country's international image and influence. Public diplomacy, on the other hand, involves the management of international political communication to advance a country's interests and values. The relationship between these two concepts can be understood through the lens of strategic communication, soft power, and international relations. Public diplomacy is based on a complex relationship between the government, the media, and public opinion Gilboa (2008). It involves efforts to establish and maintain mutually beneficial relationships with strategic publics that can affect the national interest (Steane et al., 2022). In this context, Technology Management Policy can significantly influence a country's public diplomacy efforts by shaping its technological capabilities and innovation landscape. The integration of Science, Technology, and Innovation (STI) policy within the overall framework of national development planning is crucial for the advancement of a country's technological capabilities. This technological advancement can enhance a country's international standing and attractiveness, thereby contributing to its public diplomacy objectives.

Furthermore, public diplomacy is closely related to the concept of soft power, which emphasizes the ability to persuade and create reputation, as well as cultural and institutional attractiveness. Technology Management Policy can contribute to a country's soft power by fostering innovation, research, and development, which in turn enhances its international reputation and influence. The use of various tools, including digital diplomacy and cultural exchange programs, to enhance a country's international standing and influence is also part of public diplomacy. Technology, especially digital technology, plays a crucial role in modern public diplomacy efforts, and a country's technological capabilities, driven by its Technology Management Policy, can significantly impact its digital diplomacy initiatives (Zamanli, 2022). Moreover, public diplomacy is considered as one of the most important elements of soft power that states use to promote their values and ideas. In this context, a country's technological advancements, driven by its Technology Management Policy, can serve as a demonstration of its values and ideas, thereby contributing to its public diplomacy objectives. The promotion of a country's technological achievements through public diplomacy initiatives can enhance its global image and influence. In conclusion, the relationship between Technology Management Policy and Public Diplomacy is characterized by the influence of technological capabilities on a country's international image, soft power, and strategic communication efforts. A country's technological advancements, driven by its Technology Management Policy, can significantly contribute to its public diplomacy objectives by enhancing its international standing, attractiveness, and influence.

3. Technology Management Policy as a Public Diplomacy component

The evaluation of Technology Management Policy as a component of Public Diplomacy is a complex and multifaceted endeavor. The relationship between these two concepts is crucial in shaping a country's international image, influence, and soft power. The integration of Science, Technology, and Innovation (STI) policy within the overall framework of national development planning is crucial for the advancement of a country's technological capabilities (Oladeji & Adegboye, 2019). This technological advancement can enhance a country's international standing and attractiveness, thereby contributing to its public diplomacy objectives ("China's Digital Public Diplomacy during the 2022 Beijing Winter Olympics", 2022). Furthermore, the digital aspect of public diplomacy is increasingly important in the modern era. China's Digital Public Diplomacy during the 2022 Beijing Winter Olympics highlights the significance of digital diplomacy in shaping the national image and enhancing its soft power ("China's Digital Public Diplomacy during the 2022 Beijing Winter Olympics", 2022). Similarly, Russia's Foreign Policy and Public Diplomacy emphasize the role of public diplomacy in creating a positive reputation and brand for the country, thereby increasing its soft power potential (Simons, 2020). These examples underscore the importance of technology management policies in leveraging digital tools for public diplomacy initiatives. Moreover, the Science and Technology Policy for Nigeria's Development Planning emphasizes the interrelations between STI and national development, highlighting the role of technology management policies in driving sustainable development and economic growth (Oladeji & Adegboye, 2019). This underscores the potential of technology management policies to contribute to a country's public diplomacy by showcasing its advancements in science and technology as a means of enhancing its international reputation and influence. Additionally, Public Diplomacy in Strengthening India: Vietnam Relations emphasizes the role of public diplomacy in maintaining the stability and development of bilateral relations, highlighting the importance of strategic communication and relationship-building in international affairs (Nga & Quang, 2021). In this context, technology management policies can play a significant role in enhancing a country's public diplomacy efforts by showcasing its technological achievements and fostering collaboration with other nations. In conclusion, the evaluation of Technology Management Policy as a component of Public Diplomacy underscores the interconnectedness of these concepts in shaping a country's international image, influence, and soft power. The integration of technology management policies within public diplomacy initiatives can significantly contribute to a country's efforts to advance its interests, values, and international standing. These references provide insights into the role of technology management policies in shaping a country's international image, influence, and soft power, thereby highlighting their significance as a component of public diplomacy.

4. Turkey's National Technology Management Policy

The National Technology Management Policy of Turkey plays a significant role in shaping the country's international image, influence, and soft power. Turkey has a president-directed national policy network, which underscores the centralized approach to policy formulation and implementation Bakır (2020). This centralized approach is crucial in aligning technology management policies with the country's strategic objectives, including those related to public diplomacy. The adoption rates of electronic health records in Turkish hospitals and their relation to hospital sizes highlight the role of technology in the healthcare sector. The results of such initiatives are used by the Turkish Ministry of Health to disseminate the nationwide benefits of electronic health record functions, showcasing Turkey's technological advancements in the healthcare domain (Kose et al, 2020). This not only contributes to the country's public diplomacy efforts by highlighting its achievements in healthcare technology but also enhances its international reputation in the healthcare sector. Furthermore, Turkey's response to the COVID-19 pandemic, characterized by a centralized approach involving the President, the Ministry of Interior, the Ministry of Health, and the SAB as central players, demonstrates the country's ability to leverage technology and policy coordination in managing a global crisis (Oztig, 2022). This response reflects Turkey's technological capabilities and crisis management strategies, which can significantly influence its international standing and public diplomacy efforts. In addition, the establishment of the Turkish Space Agency and the appointment of the Scientific and Technological Research Council of Turkey (TÜBİTAK) as the main organization responsible for coordinating space-based activities underscore Turkey's advancements in space technology and it's potential impact on the country's international image and influence (Ercan & Kale, 2017). The evaluation of Technology Management Policy as a component of Turkey's public diplomacy highlights the interconnectedness of technology, policy, and international relations. Turkey's technological advancements, crisis management strategies, and space exploration initiatives contribute to its public diplomacy objectives by showcasing its achievements, capabilities, and contributions to global challenges. These initiatives not only enhance Turkey's international reputation but also position the country as a significant player in the global technological landscape. The role of Technology Transfer Offices (TTOs) within Turkey's National Technology Management Policy is significant in fostering innovation, knowledge exchange, and economic development. TTOs play a crucial role in facilitating the transfer of technologies and knowledge between universities, research institutions, and industry, thereby contributing to the country's technological advancement and competitiveness. The evolving state-of-the-art in technology transfer research emphasizes the contingent effectiveness of TTOs, where their role in developing and transferring technology is recognized by policy superiors, leading to increased funding or other resources Bozeman et al. (2015). This underscores the importance of acknowledging the impact of TTOs within the policy framework and their contribution to national socio-economic development. Empirical evidence from Turkish export companies highlights the impact of technology transfer on innovation and firm performance, emphasizing the role of TTOs in organizing activities to increase technological development (Çinar et al. 2020). This demonstrates the pivotal role of TTOs in driving technological advancement and fostering a culture of innovation within the Turkish business landscape. Furthermore, the drivers of patent performance of University Science Parks in Turkey include TTOs, emphasizing their significance in promoting intellectual property rights and technology commercialization (Ünlü et al, 2022). TTOs serve as intermediaries between science, policy, industry, and the public, becoming indispensable in the technology transfer process (Sinell et al, 2018). The critical analysis of building technology transfer capacity in Turkish universities underscores the significant government funding received by university technology transfer since 2012, highlighting the strategic importance of TTOs in leveraging resources for technology transfer initiatives (Ranga et al, 2016). The role of TTOs in facilitating the successful transfer of technologies and knowledge between universities and industry is emphasized, indicating their potential to play al significant role in stimulating innovation and economic development (Fai et al, 2018). This underscores the broader impact of TTOs on the country's innovation ecosystem and economic growth. In conclusion, TTOs play a pivotal role within Turkey's National Technology Management Policy by serving as key facilitators in technology transfer, innovation, and knowledge exchange. Their impact extends to fostering economic development, promoting intellectual property rights, and driving technological advancement, thereby contributing to Turkey's competitiveness and growth in the global technological landscape.

5. Research Methodology

The research methods employed in the study of Turkey's public diplomacy and technology management policies primarily involve qualitative analysis, which includes a comprehensive review of existing literature, policy documents, and case studies. This approach allows for an in-depth understanding of the interrelations between technology management, public diplomacy, and their implications for Turkey's international relations. The qualitative nature of the research enables the exploration of complex relationships and the contextual factors influencing the effectiveness of Technology Transfer Offices (TTOs) and technology policies in Turkey. Data sources for this research include government reports, academic publications, and case studies that detail the operations and impacts of TTOs within Turkish universities and industries. These sources provide empirical evidence of the role TTOs play in facilitating technology transfer and innovation, as well as insights into the broader implications of

technology management policies on public diplomacy. Additionally, international examples of public diplomacy efforts, such as China's digital diplomacy during the 2022 Winter Olympics, are referenced to draw parallels and highlight best practices that Turkey could adopt. The evaluation and analysis of the data will be conducted through thematic analysis, focusing on identifying patterns and themes related to the effectiveness of TTOs and the impact of technology management policies on public diplomacy. This method allows for the synthesis of findings across different contexts and the extraction of actionable insights that can inform policy recommendations. Furthermore, the analysis will consider the strategic communication aspects of public diplomacy, examining how technology management can enhance Turkey's soft power and international standing. By integrating these various elements, the research aims to provide a comprehensive understanding of how Turkey can leverage its technological advancements to strengthen its public diplomacy efforts and international relations. In summary, the research employs qualitative methods, utilizes diverse data sources, and applies thematic analysis to evaluate the interplay between technology management policies and public diplomacy in Turkey.

6. Empirical Data / Case Studies on Turkey's National Technology Management Policy and TTOs in Public Diplomacy

Turkey's National Technology Management Policy has significantly influenced its public diplomacy by enhancing the country's soft power and shaping its international image. This policy emphasizes technological innovation and development as key components of Turkey's foreign relations strategy, thereby allowing the nation to project a modern, progressive image on the global stage. The integration of technology into public diplomacy efforts has enabled Turkey to engage more effectively with foreign audiences, particularly through digital platforms. One of the primary ways in which Turkey's National Technology Management Policy has impacted public diplomacy is through the promotion of a "Turkish model" of governance and humanitarian response, particularly in the context of the Syrian refugee crisis. Çevik and Sevin argue that Turkey has framed its response to this crisis as a demonstration of its benevolence and efficiency compared to the international community, thus enhancing its soft power and public image (Çevik & Sevin, 2017). This framing not only serves to bolster Turkey's reputation but also positions it as a leader in humanitarian efforts, which is a crucial aspect of effective public diplomacy. Moreover, the emphasis on technology and innovation in Turkey's public diplomacy aligns with broader trends observed in global diplomacy, where countries are increasingly leveraging digital tools to engage with international audiences. The rise of digital diplomacy, as discussed by Kalachishvili, highlights how technological advancements have transformed diplomatic practices, allowing states to communicate more directly and effectively with foreign publics (Kalachıshvili, 2023). This shift is particularly relevant for Turkey, which has utilized social media and other digital platforms to disseminate its narratives and engage with diverse audiences, thereby enhancing its diplomatic outreach. Additionally, Turkey's focus on education and cultural diplomacy, as noted by Donelli, has been instrumental in fostering positive perceptions of the country abroad. By promoting its cultural heritage and educational initiatives, Turkey has sought to build stronger ties with other nations, which is a critical element of its public diplomacy strategy (Donelli, 2019). This approach not only helps to mitigate the negative impacts of domestic political challenges but also reinforces Turkey's image as a culturally rich and welcoming nation. Furthermore, the integration of technology into public diplomacy efforts has facilitated more interactive and participatory forms of engagement. As highlighted by Huang, the historical-discursive analytical method can be applied to understand how Turkey's public diplomacy institutions have evolved to incorporate modern communication strategies that resonate with global audiences (Huang, 2021). This evolution reflects a broader trend in which states are adapting their diplomatic practices to leverage technological advancements, thereby enhancing their effectiveness in the international arena. In conclusion, Turkey's National Technology Management Policy has profoundly impacted its public diplomacy by fostering a narrative of innovation and benevolence, enhancing its soft power, and facilitating more effective engagement with global audiences through digital platforms. This multifaceted approach not only strengthens Turkey's international image but also positions it as a key player in the evolving landscape of global diplomacy.

International technology transfer initiatives have played a crucial role in shaping international relations by fostering economic development, enhancing industrial capabilities, and facilitating cooperation among nations. These initiatives are particularly significant in the context of developing countries, where technology transfer can bridge gaps in technical knowledge and infrastructure, thereby influencing diplomatic ties and economic partnerships. One notable example of technology transfer influencing international relations is China's approach to industrial restructuring through international technology transfer. Shuyuan and Ma highlight that under China's "New Normal" economic policy, international technology transfer has been pivotal in driving the transformation and upgrading of its industrial structure. This process has not only facilitated the modernization of China's industries but has also positioned the country as a significant player in global supply chains, thereby enhancing its diplomatic leverage and economic partnerships with other nations (Shuyuan & Ma, 2016). The authors argue that the successful integration of foreign technologies has led to improved productivity and competitiveness, which in turn strengthens China's position in international negotiations and collaborations. Similarly, the Regional Comprehensive Economic Partnership (RCEP) has established provisions related to technology transfer that significantly impact

international scientific and technological cooperation among member states. Sun's empirical study indicates that these provisions, which include aspects like absorptive capacity and international personnel mobility, have fostered closer ties between developing economies within the RCEP framework. This cooperative environment not only enhances technological capabilities but also promotes diplomatic relations among member countries, as they work collaboratively to address common challenges and leverage shared technological advancements (Sun, 2024). The findings underscore the importance of structured technology transfer agreements in facilitating international cooperation and enhancing diplomatic relations. Moreover, the construction sector in developing nations has also seen significant impacts from international technology transfer initiatives. Waroonkun and Stewart discuss how many developing countries have engaged in technology transfer to improve their infrastructure capabilities. However, they note that despite these efforts, there is often a sustained reliance on foreign firms due to the challenges in fully assimilating and utilizing the transferred technologies (Waroonkun & Stewart, 2007). This dynamic can lead to complex diplomatic relationships, as countries navigate the balance between dependence on foreign expertise and the desire for self-sufficiency in technology and infrastructure development. In addition, the role of technology transfer in enhancing productivity and innovation is evident in the context of Taiwan's industrial growth. Branstetter and Chen's analysis reveals that technology transfer, combined with research and development (R&D) efforts, has significantly contributed to productivity growth in Taiwanese industries. This synergy between technology transfer and local innovation capabilities has allowed Taiwan to strengthen its economic position and diplomatic relations, particularly with countries seeking to engage in trade and investment partnerships (Branstetter & Chen, 2006). In conclusion, technology transfer initiatives have profound implications for international relations by enhancing economic capabilities, fostering cooperation, and shaping diplomatic ties. Countries that effectively leverage technology transfer not only improve their industrial competitiveness but also enhance their standing in the global arena, facilitating stronger diplomatic relationships and collaborative efforts.

Technology transfer initiatives have yielded measurable outcomes across economic, technological, and diplomatic dimensions, significantly influencing international relations. These outcomes can be observed through various case studies and analyses that highlight the impact of technology transfer on development, productivity, and international cooperation. Economically, technology transfer has been shown to enhance productivity and foster economic growth, particularly in developing countries. For instance, the study by Zhong indicates that foreign technology transfer positively impacts firm productivity, especially in regions with varying levels of economic development (Zhong, 2022). This relationship underscores the importance of technology transfer as a catalyst for economic advancement, which can lead to improved trade relations and investment opportunities between nations. Furthermore, the research by Chhetri emphasizes the role of foreign direct investment (FDI) as a significant driver of economic growth in developing countries, highlighting how FDI facilitates technology transfer and enhances local capabilities (Chhetri, 2022). This economic interdependence often translates into stronger diplomatic ties, as countries seek to maintain favorable conditions for investment and technology exchange. Technologically, the outcomes of technology transfer initiatives are evident in the advancements in local innovation systems and capabilities. The work of Yiblet discusses how partnerships within the BRICS framework have led to enhanced technological collaboration, particularly in African countries (Yiblet, 2024). Such collaborations not only improve technological capacities but also foster a sense of shared purpose and mutual benefit among participating nations, thereby strengthening diplomatic relations. Additionally, the systematic literature review by Zanello et al. Reveals that technology transfer contributes to the creation and diffusion of innovations in developing countries, which is crucial for building sustainable economic systems and enhancing global competitiveness (Zanello et al, 2015). This diffusion of technology can lead to the emergence of new industries and sectors, further solidifying the technological foundation of international partnerships. Diplomatically, technology transfer initiatives often serve as tools for fostering cooperation and building alliances. The Belt and Road Initiative (BRI) exemplifies this, as it emphasizes technology transfer as a core component of its strategy to enhance economic development and connectivity among participating countries (Raslan, 2024). The BRI not only facilitates infrastructure development but also promotes knowledge sharing and capacity building, which can lead to stronger diplomatic relationships. Moreover, the findings of Cunningham et al. Highlight how university-focused technology transfer policies can stimulate regional innovation and entrepreneurship, thereby enhancing the diplomatic standing of countries that invest in education and research (Cunningham et al, 2019). By positioning themselves as leaders in technology transfer, nations can enhance their soft power and influence in international forums. In summary, technology transfer initiatives yield measurable outcomes that significantly impact economic growth, technological advancement, and diplomatic relations. These initiatives not only enhance local capabilities and foster innovation but also create opportunities for countries to collaborate and build stronger international partnerships.

7. Evaluation of Turkey’s Centralized Approach to Policymaking

Turkey's centralized policy-making approach significantly shapes its Technology Management Policy by establishing a framework that emphasizes top-down decision-making, rapid implementation, and alignment with national strategic objectives. This approach is characterized by a concentration of authority within the executive branch, particularly under the

governance of the Justice and Development Party (AKP), which has reinforced authoritarian features in policy-making processes (Öztığ, 2022). The implications of this centralized approach are multifaceted, impacting the formulation, implementation, and effectiveness of technology management initiatives. One of the primary outcomes of Turkey's centralized policymaking is the swift execution of technology management strategies that align with national priorities. The AKP's governance model allows for decisive action in areas deemed critical for national development, such as defense technology and information and communication technologies. This is evident in initiatives like the National Technology Initiative, which aims to enhance domestic production capabilities and reduce dependency on foreign technologies. The centralized nature of decision-making facilitates the allocation of resources and prioritization of projects that support Turkey's strategic goals, particularly in sectors such as defense and aerospace (Elswah & Howard, 2021). Moreover, the centralized policy-making framework has implications for stakeholder engagement in technology management. Öztığ notes that the low level of inclusion in policy-making processes can lead to disconnect between government objectives and the needs of various stakeholders, including industry players and academia (Öztığ, 2022). This lack of inclusivity may hinder the effectiveness of technology transfer and innovation initiatives, as the perspectives and expertise of key actors are often overlooked. Consequently, while the centralized approach allows for rapid decision-making, it may also result in policies that are less responsive to the dynamic needs of the technology sector. In addition, Turkey's centralized approach influences its international technology management policies and diplomatic relations. The government often utilizes technology transfer agreements as tools for enhancing bilateral relations, particularly with countries in the Middle East and Africa. By positioning itself as a technology provider, Turkey seeks to strengthen its soft power and foster cooperative relationships through technology-sharing initiatives (Çevik, 2019). This strategy aligns with the broader goals of Turkey's foreign policy, which emphasizes the importance of economic partnerships and regional influence. Furthermore, the emphasis on a centralized policy framework has implications for the evaluation and accountability of technology management initiatives. As noted by Danziger and Schreiber, the Turkish Ministry of Foreign Affairs has adopted a digital diplomacy approach that reflects the centralized nature of its governance (Danziger & Schreiber, 2021). This approach not only serves to project Turkey's image abroad but also allows for greater control over the narrative surrounding its technology initiatives. However, the focus on centralized messaging can sometimes obscure the complexities and challenges faced in the implementation of technology management policies. In conclusion, Turkey's centralized policy-making approach significantly shapes its Technology Management Policy by facilitating rapid decision-making and resource allocation while also presenting challenges related to stakeholder engagement and responsiveness. This framework allows Turkey to pursue its strategic objectives in technology management, enhancing its international standing and fostering diplomatic relationships, albeit with potential limitations in inclusivity and adaptability.

Turkey's centralized policy-making structure has produced several positive outcomes in terms of international relations and public diplomacy. This approach allows for swift decision-making, coherent strategic direction, and the ability to mobilize resources effectively, which can enhance Turkey's standing on the global stage. One significant positive outcome is the ability to implement foreign policy initiatives rapidly and decisively. The centralized governance model enables the Turkish government to respond quickly to international crises or opportunities, as seen in its involvement in the Syrian conflict. Zulham et al. discuss how Turkey's centralized defense management has allowed it to establish itself as a key player in regional security dynamics, fostering relationships with both NATO and Russia (Zulham et al., 2020). This agility in policymaking enhances Turkey's diplomatic leverage, allowing it to navigate complex geopolitical landscapes effectively. Additionally, Turkey's centralized approach has facilitated the establishment of strategic partnerships, particularly in the context of its relations with Azerbaijan. The historical and cultural ties between the two nations have been leveraged through a centralized foreign policy that emphasizes mutual interests in energy and security ("The Flourishing Economic and Political Relations of Turkey & Azerbaijan: An Overview after 30th Diplomatic Anniversary", 2023). This relationship not only strengthens Turkey's regional influence but also serves as a model for its diplomatic engagements with other countries in the Turkic world and beyond. Moreover, the centralized policy-making structure has allowed Turkey to pursue a clear narrative in its public diplomacy efforts. By controlling the messaging and strategic objectives, the government can project a cohesive image internationally. Gafarli notes that Turkey's pursuit of strategic autonomy has led to a more assertive foreign policy, which is crucial for enhancing its diplomatic relations with major powers (GAFARLI, 2023). This narrative control helps Turkey to position itself as a regional leader, capable of mediating conflicts and fostering cooperation among diverse actors. The centralized structure also enables Turkey to prioritize technology transfer and innovation as key components of its foreign policy. By focusing on high-technology exports and partnerships, Turkey aims to enhance its economic competitiveness while simultaneously strengthening diplomatic ties with countries that are willing to engage in technology sharing. This is particularly relevant in the context of Turkey's relationships with countries in Central Asia and the Middle East, where technology transfer initiatives can serve as a foundation for deeper economic and political collaboration. However, the specific implications of these initiatives require further exploration in the context of Turkey's broader foreign policy goals (Hovsepyan, 2023). Furthermore, Turkey's centralized approach has implications for its soft power strategy. By actively engaging in humanitarian efforts and development aid, Turkey has positioned itself as a benevolent actor in international

relations. This is particularly evident in its response to the Syrian refugee crisis, where the government has utilized its centralized decision-making capabilities to coordinate aid and support initiatives effectively (Zulham et al., 2020). Such actions enhance Turkey's image abroad and contribute to its public diplomacy efforts, fostering goodwill and strengthening bilateral relations. In conclusion, Turkey's centralized policy-making structure yields several positive outcomes in international relations and public diplomacy. The ability to implement policies swiftly, establish strategic partnerships, control narratives, prioritize technology transfer, and engage in humanitarian efforts enhances Turkey's diplomatic standing and fosters cooperative relationships with other nations.

While Turkey's centralized policy-making approach has yielded several positive outcomes in terms of international relations and public diplomacy, it also presents notable downsides that can hinder effective governance and public engagement. These downsides include reduced local autonomy, limited stakeholder participation, potential inefficiencies, and risks of authoritarianism, which can adversely affect both domestic and international perceptions of Turkey. One significant downside of a centralized approach is the erosion of local autonomy and the capacity of local governments to respond effectively to regional needs. Kuyucu highlights that the excessively centralized nature of public administration in Turkey can lead to institutional conflicts and increased transaction costs, as local governments struggle to coordinate with central authorities Kuyucu (2020). This disconnect can result in policies that are not well-suited to local contexts, ultimately undermining the effectiveness of initiatives aimed at fostering development and innovation. The lack of local input can also diminish the legitimacy of government actions, leading to public discontent and resistance. Moreover, the limited inclusion of civil society and other stakeholders in the decision-making process can stifle innovation and responsiveness. Öztığ points out that the hierarchical bureaucratic structure in Turkey often excludes key actors, such as professional associations and local experts, from meaningful participation in policy formulation (Öztığ, 2022). This exclusion can result in policies that do not adequately address the complexities of the issues at hand, leading to ineffective or poorly designed initiatives. The lack of diverse perspectives can also hinder the government's ability to adapt to changing circumstances, both domestically and internationally. Another potential downside is the risk of inefficiencies arising from a top-down approach. Centralized decision-making can lead to bureaucratic delays and a lack of flexibility in responding to emerging challenges. Hermansson notes that the disjointed political-administrative system in Turkey can hinder effective communication and collaboration between central and local authorities, particularly in disaster management contexts (Hermansson, 2018). Such inefficiencies can undermine the government's ability to respond to crises effectively, affecting public trust and international credibility. Furthermore, the centralization of power can foster an environment conducive to authoritarianism, which can have detrimental effects on Turkey's international relations. The increasing concentration of power within the executive branch has raised concerns about democratic backsliding and the erosion of civil liberties (Tepe & Alemdaroğlu, 2021). This authoritarian trend can alienate potential allies and partners, as countries may be hesitant to engage with a government perceived as undemocratic. The perception of Turkey as an authoritarian state can also impact its soft power and public diplomacy efforts, as nations may be less inclined to support or collaborate with a government that does not uphold democratic values. In conclusion, while Turkey's centralized policy-making approach has facilitated rapid decision-making and strategic coherence, it also presents significant downsides, including reduced local autonomy, limited stakeholder participation, potential inefficiencies, and risks of authoritarianism. These challenges can hinder effective governance and adversely affect Turkey's international relations and public diplomacy efforts.

8. Policy Implications and Recommendations

The findings regarding Turkey's public diplomacy and technology management have significant implications for future policy decisions. The integration of technology management policies with public diplomacy efforts is essential for enhancing Turkey's international image and soft power. A well-coordinated approach that aligns technological advancements with public diplomacy can bolster a nation's influence and attractiveness on the global stage. This alignment is crucial for Turkey as it seeks to navigate complex international relations and enhance its standing through strategic communication and relationship-building. Moreover, Turkey can strategically develop its public diplomacy through advancements in technology management and Technology Transfer Offices (TTOs). TTOs serve as vital intermediaries that facilitate the transfer of knowledge and technology between universities and industry, which is crucial for fostering innovation and economic development. By enhancing the capacity and effectiveness of TTOs, Turkey can better leverage its scientific and technological advancements to promote its values and ideas internationally, thereby strengthening its public diplomacy efforts. The establishment of a robust national technology management policy that supports TTOs can create synergies between technological innovation and public diplomacy, ultimately enhancing Turkey's global influence. To enhance the effectiveness of TTOs and technology policies in strengthening Turkey’s international relations, several recommendations can be made. First, increasing government funding and support for TTOs is essential to ensure they have the necessary resources to operate effectively and foster collaboration between academia and industry. Additionally, implementing training programs for TTO personnel can improve their capabilities in technology commercialization and intellectual property management, which are critical for successful technology

transfer. Furthermore, Turkey should prioritize the development of digital diplomacy initiatives that utilize its technological advancements to engage with international audiences effectively. By doing so, Turkey can not only showcase its innovations but also build meaningful relationships that enhance its soft power and international standing. In conclusion, the integration of technology management policies with public diplomacy efforts is vital for Turkey's strategic development. By enhancing the capacity of TTOs and leveraging technological advancements, Turkey can significantly improve its international relations and public diplomacy outcomes.

9. Conclusion

In conclusion, the interplay between Turkey's National Technology Management Policy and its public diplomacy initiatives underscores the significance of technological advancement in shaping the country's international image and influence. As public diplomacy evolves into a multifaceted instrument for states to promote their values and interests, Turkey's strategic focus on technology management plays a pivotal role in enhancing its soft power. The integration of Science, Technology, and Innovation (STI) policies within national development planning not only fosters innovation but also positions Turkey as a competitive player on the global stage, thereby advancing its public diplomacy objectives. The establishment of Technology Transfer Offices (TTOs) within Turkish universities further exemplifies this relationship, as these entities facilitate the transfer of knowledge and technology between academia and industry, contributing to the nation's technological capabilities and economic development. By showcasing its advancements in various sectors, particularly in healthcare technology through initiatives like the adoption of electronic health records, Turkey enhances its international reputation and demonstrates its commitment to leveraging technology for public diplomacy. Moreover, the centralized approach to policy formulation and implementation, as seen in Turkey's response to global challenges such as the COVID-19 pandemic, highlights the effectiveness of coordinated efforts in utilizing technology to bolster public diplomacy. This strategic alignment between technology management and public diplomacy not only enhances Turkey's global standing but also fosters collaboration with other nations, ultimately contributing to a more robust and influential international presence. In summary, Turkey's commitment to integrating technology management policies within its public diplomacy framework serves as a vital strategy for enhancing its soft power and international influence, showcasing the importance of innovation and technological advancement in contemporary international relations

References

Niu, Y. (2022). China's Digital Public Diplomacy during the 2022 Beijing Winter Olympics. *Journal of Political Science Research*, *3*(1), 44-53. https://doi.org/10.23977/polsr.2022.030107

Kayani, F. N. (2023). The Flourishing Economic and Political Relations of Turkey & Azerbaijan: An Overview after 30th Diplomatic Anniversary. *Eurasian Journal of Social Sciences*, *11*(2), 68-74. https://doi.org/10.15604/ejss.2023.11.02.003

Alemna, A. (1999). The impact of new information technology in Africa. Information Development, 15(3), 167-170. https://doi.org/10.1177/0266666994239868

Bakır, C. (2020). The Turkish state's responses to existential covid-19 crisis. Policy and Society, 39(3), 424-441. https://doi.org/10.1080/14494035.2020.1783786

Bozeman, B., Rimes, H., & Youtie, J. (2015). The evolving state-of-the-art in technology transfer research: revisiting the contingent effectiveness model. Research Policy, 44(1), 34-49. https://doi.org/10.1016/j.respol.2014.06.008

Branstetter, L. and Chen, J. (2006). The impact of technology transfer and r & d on productivity growth in Taiwanese industry: microeconometric analysis using plant and firm-level data. Journal of the Japanese and International Economies, 20(2), 177-192. https://doi.org/10.1016/j.jjie.2005.11.001

Chhetri, H. (2022). Foreign trade, foreign direct investment and economic growth in Nepal. Janapriya Journal of Interdisciplinary Studies, 11(1), 75-93. https://doi.org/10.3126/jjis.v11i1.51648

Cunningham, J., Lehmann, E., Menter, M., & Seitz, N. (2019). The impact of university focused technology transfer policies on regional innovation and entrepreneurship. The Journal of Technology Transfer, 44(5), 1451-1475. https://doi.org/10.1007/s10961-019-09733-0

Çevik, S. (2019). Reassessing turkey's soft power: the rules of attraction. Alternatives Global Local Political, 44(1), 50-71. https://doi.org/10.1177/0304375419853751

Çevik, S. and Sevin, E. (2017). A quest for soft power: turkey and the Syrian refugee crisis. Journal of Communication Management, 21(4), 399-410. https://doi.org/10.1108/jcom-04-2017-0042

Çinar, Ö. Altuntas, S., & Alan, M. (2020). Technology transfer and its impact on innovation and firm performance: empirical evidence from Turkish export companies. Kybernetes, 50(7), 2179-2207. https://doi.org/10.1108/k-12-2019-0828

Danziger, R. and Schreiber, M. (2021). Digital diplomacy: face management in mfa twitter accounts. Policy & Internet. https://doi.org/10.1002/poi3.269

Doncel-Martín, I., Catalan-Matamoros, D., & Elías, C. (2022). Corporate social responsibility and public diplomacy as formulas to reduce hate speech on social media in the fake news era. Corporate Communications an International Journal, 28(2), 340-352. https://doi.org/10.1108/ccij-04-2022-0040

Donelli, F. (2019). Persuading through culture, values and ideas: the case of turkey's cultural diplomacy. Insight Turkey. https://doi.org/10.25253/99.2019ev.04

Elswah, M. and Howard, P. (2021). Where news could not inspire change: trt world as a party broadcaster. Journalism, 23(10), 2079-2095. https://doi.org/10.1177/14648849211033444

Ercan, C. and Kale, I. (2017). Historical space steps of turkey: it is high time to establish the Turkish space agency. Acta Astronautica, 130, 67-74. https://doi.org/10.1016/j.actaastro.2016.10.019

Fai, F., Beer, C., & Schutte, C. (2018). Towards a novel technology transfer office typology and recommendations for developing countries. Industry and Higher Education, 32(4), 213-225. https://doi.org/10.1177/0950422218780614

Gafarli, O. (2023). Relations with Russia in the context of turkey's policy in constructing its 'strategic autonomy'. Uluslararası İ·lişkiler Dergisi, 20(79), 33-50. https://doi.org/10.33458/uidergisi.1358280

Gilboa, E. (2008). Searching for a theory of public diplomacy. The Annals of the American Academy of Political and Social Science, 616(1), 55-77. https://doi.org/10.1177/0002716207312142

Hermansson, H. (2018). Challenges to decentralization of disaster management in turkey: the role of political-administrative context. International Journal of Public Administration, 42(5), 417-431. https://doi.org/10.1080/01900692.2018.1466898

Hovsepyan, L. (2023). The main factors underpinning turkey–china relations: the 'turkic world' narrative and its implications for future relations. China Report, 59(4), 456-472. https://doi.org/10.1177/00094455231188100

Huang, Z. (2021). A historical–discursive analytical method for studying the formulation of public diplomacy institutions. Place Branding and Public Diplomacy, 18(3), 204-215. https://doi.org/10.1057/s41254-021-00246-y

Jia, Y., Liu, C., Chen, Y., & Zhu, Q. (2020). The construction of science and technology innovation policy design framework—take Shandong province as an example. Journal of Industry-University Collaboration, 2(1), 34-48. https://doi.org/10.1108/jiuc-08-2019-0015

Kalachishvili, M. (2023). Digital age of diplomacy and its impact on foreign policy. HUM, 12(1). https://doi.org/10.31578/hum.v12i1.515

Kose, I., Rayner, J., Birinci, S., Ulgu, M., Yilmaz, I., & Guner, S. (2020). Adoption rates of electronic health records in Turkish hospitals and the relation with hospital sizes. BMC Health Services Research, 20(1). https://doi.org/10.1186/s12913-020-05767-5

Kuyucu, T. (2020). The great failure: the roles of institutional conflict and social movements in the failure of regeneration initiatives in Istanbul. Urban Affairs Review, 58(1), 129-163. https://doi.org/10.1177/1078087420957736

Manfredi-Sánchez, J. (2022). Thinking about Latin American public diplomacy. Latin American Policy, 13(1), 6-19. https://doi.org/10.1111/lamp.12242

Mazumdar, A. (2020). India's public diplomacy in the twenty-first century: components, objectives and challenges. India Quarterly a Journal of International Affairs, 76(1), 24-39. https://doi.org/10.1177/0974928419901188

Namuq, B. and Al-BAYATI, M. (2021). Employing digital diplomacy in foreign policy: Israel as a model IAGS. https://doi.org/10.7176/iags/90-05

Nga, L. and Quang, T. (2021). Public diplomacy in strengthening India: Vietnam relations. India Quarterly a Journal of International Affairs, 77(2), 289-303. https://doi.org/10.1177/09749284211005012

Oladeji, S. and Adegboye, A. (2019). Science and technology policy for Nigeria's development planning. Journal of Education Society and Behavioural Science, 1-12. https://doi.org/10.9734/jesbs/2019/v32i430182

Oztig, L. (2022). Policy styles and pandemic management: the case of turkey. European Policy Analysis, 8(3), 261-276. https://doi.org/10.1002/epa2.1155

Pavón-Guinea, A. (2023). « it's the context, stupid»: the european union's public diplomacy in times of ontological insecurity. Communication & Society, 291-309. https://doi.org/10.15581/003.36.2.291-309

Ranga, M., Temel, S., Ar, İ., Yeşilay, R., & Sukan, F. (2016). Building technology transfer capacity in Turkish universities: a critical analysis. European Journal of Education, 51(1), 90-106. https://doi.org/10.1111/ejed.12164

Raslan, R. (2024). Climbing up the ladder: technology transfer-related policies in the context of the belt and road initiative. Utrecht Law Review, 20(1), 19-43. https://doi.org/10.36633/ulr.922

Shuyuan, X. and Ma, H. (2016). Analysis on the impact of international technology transfer on china's industrial restructuring and upgrading. International Journal of Innovation Management and Technology, 7(3), 86-89. https://doi.org/10.18178/ijimt.2016.7.3.650

Simons, G. (2020). Russian foreign policy and public diplomacy: meeting 21st century challenges. Vestnik Rudn International Relations, 20(3), 491-503. https://doi.org/10.22363/2313-0660-2020-20-3-491-503

Sinell, A., Iffländer, V., & Muschner, A. (2018). Uncovering transfer – a cross-national comparative analysis. European Journal of Innovation Management, 21(1), 70-95. https://doi.org/10.1108/ejim-01-2017-0006

Steane, N., Hwang, E., & Coluccello, S. (2022). South Korea's public diplomacy actors in Uzbekistan. European Journal of Korean Studies, 95-124. https://doi.org/10.33526/ejks.20222201.95

Sun, Y. (2024). The impact of the depth of technology transfer type provisions in regional trade agreements on international science and technology cooperation - an empirical study based on rcep member countries. 61-67. https://doi.org/10.2991/978-94-6463-408-2_8

Tepe, S. and Alemdaroğlu, A. (2021). How authoritarians win when they lose. Journal of Democracy, 32(4), 87-101. https://doi.org/10.1353/jod.2021.0054

Ünlü, H., Temel, S., & Miller, K. (2022). Understanding the drivers of patent performance of university science parks in turkey. The Journal of Technology Transfer, 48(3), 842-872. https://doi.org/10.1007/s10961-022-09929-x

Waroonkun, T. and Stewart, R. (2007). Modeling the international technology transfer process in construction projects: evidence from Thailand. The Journal of Technology Transfer, 33(6), 667-687. https://doi.org/10.1007/s10961-007-9043-1

White, C. (2015). Exploring the role of private-sector corporations in public diplomacy. Public Relations Inquiry, 4(3), 305-321. https://doi.org/10.1177/2046147x15614883

Yiblet, F. (2024). Unlocking new opportunities: brics partnership and its implications for economic development in African countries. Journal of Entrepreneurship and Business Innovation, 11(1), 37. https://doi.org/10.5296/jebi.v11i1.22012

Zamanli, E. (2022). Intensification cycle in digital diplomacy. Kne Social Sciences, 70-86. https://doi.org/10.18502/kss.v7i2.10278

Zanello, G., Fu, X., Mohnen, P., & Ventresca, M. (2015). The creation and diffusion of innovation in developing countries: a systematic literature review. Journal of Economic Surveys, 30(5), 884-912. https://doi.org/10.1111/joes.12126

Zhong, P. (2022). The impact of foreign technology transfer on firm productivity. https://doi.org/10.2991/aebmr.k.220405.274

Zulham, M., Saragih, H., Ambarwati, R., & Silitonga, T. (2020). Turkey's involvement in the Syrian conflict from a defense management perspective. Ajis Academic Journal of Islamic Studies, 5(2), 81. https://doi.org/10.29240/ajis.v5i2.1915