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Article title

The Determinants of Industrial Output in Pakistan: A Time Series Analysis

Abstract

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Title

The Determinants of Industrial Output in Pakistan: A Time Series Analysis

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Contents

Abstract

This study investigates the determinants of industrial growth in Pakistan through an empirical analysis of quarterly data spanning from 1970 to 2022. Industrial growth is the dependent variable, while the inflation rate, rate of exchange, foreign direct investment, gross fixed capital formation, and terms of trade are independent variables. The Autoregressive Distributed Lag (ARDL) model was employed due to the mixed stationarity, as indicated by the augmented dickey-fuller test. The results reveal a positive long-run relationship between FDI and industrial growth, as well as between gross fixed capital formation and industrial growth. Conversely, a negative relationship is observed between the exchange rate and industrial growth, and between the interest rate and industrial growth. All variables to be statistically significant, except for terms of trade. Furthermore, the inflation rate and rate of exchange show a reducing impact on industrial growth, while FDI and gross fixed capital formation contribute positively to industrial growth.

Keywords: FDI, Industrial Growth, Exchange Rate, Inflation Rate

Introduction

Industrial growth refers to the expansion of industrial production and economic activity, which have a crucial effect on the economic progress of an economy. The industries have significant contributors to economic recovery in Pakistan, despite various challenges. For example, in November 2023, the Large-Scale Manufacturing (LSM) sector grew by 3.63% on a month-on-month basis and 1.59% on a year-on-year basis, showcasing the sector's resilience and capacity to adapt to well-planned actions. Foreign Direct Investment (FDI), an essential driver of industrial growth, refers to long-term investments from foreign entities into domestic businesses, differing from passive portfolio investments. FDI promotes industrial growth by providing the capital and expertise needed for expansion. In contrast, inflation negatively affects industrial growth by reducing purchasing power and raising production costs, as it enhances the general prices of goods and services.

Gross Fixed Capital Formation (GCF) is another vital factor influencing industrial growth. It refers to the total value of investments made in a country's economy, including additions to fixed assets and inventory changes. In 2020, Pakistan's GCF stood at $40.25 billion, reflecting significant fluctuations over the years, from a high of $54.55 billion in 2018 to as low as $507 million in 1960. The exchange rate, which measures the value of one country's currency relative to another, has an important role in industrial growth. Fluctuations in the exchange rate can impact import and export prices, influencing the competitiveness of domestic industries. Additionally, the terms of trade, which calculate the proportion of export prices to import prices, identify a country that can benefit from international trade. Industrial growth in Pakistan is crucial for economic stability and social welfare. However, the country faces numerous economic, social, political, and environmental challenges that hinder industrial development. Issues such as capital formation, FDI, exchange rates, and terms of trade are critical to industrial stability.

Research seeks to follow the outcome of FDI, inflation rate, exchange rate, terms of trade, and gross capital formation on industrial growth in Pakistan. By utilizing fresh data, the research aims to enhance the understanding of the relationships between these variables and provide insights into the factors driving industrial growth in Pakistan.

Literature Review

Suriyanti and Alimuddin et al. (2024) aim to investigate the result of foreign direct investment (FDI) on industrial growth and labor prosperity in ASEAN countries. FDI inflow has made a significant phenomenon in the case of global economic activity, especially in the ASEAN geography, which is increasingly in demand as an investment destination by foreign producers. Econometric methods were used to find out the comparison between FDI, industrial productivity, and labor welfare by using panel data from ASEAN economies over a specific period. The outcome of the data shows that FDI is the imperative variable for industrial productivity in ASEAN economies. The research also found that FDI cooperates to increase the standard of the workforce through employment opportunities, technology improvement, and income generation. However, these outcomes may

exist among ASEAN countries, depending on factors such as labor-market regulatory bodies, level of literacy, and development projects. The policy recommendation of this research identifies the significant role of supporting foreign direct investment as a key aspect in enhancing economic productivity and improving prosperity in ASEAN economies. Juinie et al. (2024) identify pre-industrial productivity in Western Europe between circa 1270 and 1820. The study presents the calculation of standards of mankind, such as real wages and per capita GDP. England was a relatively stable economy in terms of wage rate after the 14th century, following the Black Death, while wages in real terms in other parts of Europe diminished over a long period of time. This "Little Divergence" between the North Sea area and the rest of the continent is also proven by investigations of per capita GDP. On the contrary, per capita GDP reduced, while Holland and England made outstanding growth—they were getting wealthier in 1750 than in 1500. Two key developments contributed to this progress. The first was the Black Death, which enhanced the standards of living in the economy near the North Sea due to productive labor and capital inflows [8]. Ottomino et al. (2024) examine an international economy mobilization with output productivity and identify the wants of certain frameworks that rely on the outcome of productivity. Whenever externalities are wealthier in the initial value of progress, global economies' transformation to the advanced technological output can enhance welfare by involving in global markets, undervaluing the rate of exchange, and racing up the aspects. Countries that do not convert to various framework technologies are forgiven by ignoring the use of the exchange rate as various industrial tactics. Productivity of capital accumulation of the countries and market of labor framework have imperative a significant role in the success of these policies. The authors also identify the key study of capital productivity as an industrial methodology and use their strategies to interpret historical experiences (Ottonello, Perez, & Witheridge, 2024). Felician et al. (2023) focused on investigating and forecasting the outcome of foreign direct investment (FDI) on industrial growth and industrial productivity in Tanzania by having World Bank data spanning from 1960 to 2020. The unit root test was implemented and the result was found that the data to be stationary at the level. The vector

autoregressive and vector error correction models were estimated, and the Granger causality test was brought to explore cause and effect between variables. Industrial growth increased by 2.5% with a two-period lag. Additionally, FDI had a positive relationship with industrial performance. The speed of adjustment for both short and long-run equilibrium was calculated by the Error Correction model that found 16% long-run adjustment. Moreover, the model identified that net barter terms, exchange rate, and gross fixed capital formation significantly result in industrial productivity.The findings proved that FDI has a multiplier impact on the economic indicators. The research concludes that the Banks of Tanzania pick effective measures to hold poor-performing economic indicators such as the exchange rate and inflation and enhance the money market to increase capital availability and accessibility (Kitole & Utouh, 2023). Mahak and Waqas (2023) aimed to explore the result of inflation, rate of exchange, and FDI in the progress of development. The researchers used time-series data from 1973 to 2020, which they gathered from sources such as the World Development Indicators and the State Bank of Pakistan. For inflation, they used the consumer price index as another term, while the other variables remained the same. The paper's goal was to answer questions such as: What percentage of inflation is beneficial to an economy? The study found that the three factors analyzed had a favorable long-term relationship with economic development. Specifically, the Pakistani economy grew fastest when inflation was below the 2.80% threshold, beyond which inflation hindered growth. The marginal effect of FDI on growth was positive when inflation was below this threshold, but negative when inflation exceeded it. In conclusion, the Pakistani government must stabilize the macroeconomic system and ensure inflation remains below the threshold to attract foreign investors (Mehak & Waqas, 2023). Mustafa and Malik (2023) emphasized the investment abroad in uprising countries. FDI introduces essential capital, new technologies, and know-how to domestic markets, stimulating progress and creating opportunities for businesses and individuals. In recent years, there has been a topic of fluctuation of interest in FDI's significance for enhancing the economic outcome. Global decisions are increasingly focused on attracting foreign investments to enhance their economies and improve living standards. In Pakistan, FDI has investigated a critical role in revolving economic productivity and development aspects. The State Bank of Pakistan showed a 137% increase in FDI inflows in the fiscal year 2020-21, totaling $2.78 billion, largely due to investments in major sectors of the economy such as energy, telecommunications, and construction. This research investigates empirical proof of the contribution between FDI and productivity in the context of Pakistan by getting the annual data from 1996 to 2022. The outcome of its research finds the impact of FDI on Gross Domestic Product (GDP), referring to factors such as political pressure, terrorism, and international trade. Majeed and Khan (2023) investigated the real relationship between economic outcomes and environmental content which is an emerging world topic. The global framework shows to decrease in environmental content to levels seen in the 1990s while maintaining economic production. This research investigates the economic framework of environmental objects in Pakistan from 1980 to 2018. The decomposition of the value presented by converging optimistic approaches, intercorrelation analysis, and impulse response function were used to set up the importance of decoupling drivers. The Tapio decoupling outcomes identify that Pakistan experienced the variation empowered during a couple of years. Johansen intercorrelation shows the relationship between the confirmed variables. The long-run model and regression either estimate or identify that carbon intensity and rural-urban migration are the main aspects of decomposition in the worth of the economy. The industrial and productivity of the economy weakened the productivity of Pakistan. The research finds the importance of converting the industrial sector's outdated and polluting geography with advanced technology and progressive renewable energy into industrial growth and urban sectors (Usman et al., 2023).

Methodology

The study was conducted in Pakistan where data has been collected annually from 1970 to 2022. This will time series approach on the basis of multiple methodologies for the respective concerned. The data has been collected through secondary sources

which are the following. World Development Indicator (WDI), Pakistan Statistical Bureau (PSB), and FRED (Yang & McCall, [2013]). The unit root test has been applied for analyzing the stationary in the variables. Then, the Autoregressive Distributed Lag (ARDL) test was applied to investigate the cointegration long-run analysis and long-run adjustment through the error correction model Phillips, [1998]. In addition. Residual diagnosis and stability tests will also be performed to understand the basic requirements of the variables. We identify dependent and independent variables in order to understand them conceptually.

The Augmented Dickey-Fuller (ADF) test follows the statistical tactics to find the stationary and non-stationary data after analyzing it through econometrics models and approaches. Variances and mean of the variables are unchanged entities over time means there are no proper fluctuating factors in the whole data time period analysis, while non-stationarity reflects the differences in the mean or variance over a specific time period.

The Augmented Dickey-Fuller test formula is:

$$\Delta f\_t = C + Bt + \alpha y\_\{t-1\} + \ddot{Y}1\Delta y\_\{t-1\} + \dots + \ddot{Y}p\Delta y\_\{t-p\} + \lambda\_t \dots \dots (1)$$

Where:

- f_t is the approach of time series data

- Δy_t = y_t - y_{t-1} it shows the first difference

- C is a constant

- B it presents the trending circumstances in the approach....(t)

- α shows the coefficient on the lagged level of the time series (y_{t-1})

- $\ddot{Y}$ 1, ..., $\ddot{Y}$ p are the coefficients on the lagged differences (Δy_{t-1}, ..., Δy_{t-p})

- λ _t presents the error term in the econometrics model.

- p shows and clarifies the number of lagged differences included in the test (chosen based on the order of serial correlation in the data).

The bound test methodology is a robust technique employed in econometrics research to examine the long-run relationships between variables. Developed by Pesaran et al. (2001), this methodology overcomes the limitations of traditional cointegration tests by accommodating variables with different orders of integration,

allowing for flexible model specification. The bound test involves estimating an ARDL model, computing the F-statistic, and comparing it to critical values in two bounds - the lower bound (assuming no cointegration) and the upper bound (assuming cointegration). Whenever the F-statistic reaches a level the same as the upper bound, cointegration is confirmed, indicating a long-run relationship.

$$Yt = \alpha + \sum^P \beta iYt - i + +\sum^{\wedge}q \ \gamma jXt - j + \epsilon t \dots \dots (2)$$

Where:

- Yt shows the dependent variable.
- Xi identifies the independent variables.
- p and q are the optimal lag lengths for Y and X, respectively.

Estimate the model using OLS (Ordinary Least Squares). The long-run approaches have not approach that showed by null hypothesis(i.e., the term which is coefficients of the lagged X variables are equal to zero):

H0 : γ1 = γ2 =....= γq = 0

The long-run approaches are shown in the alternate hypothesis :

H1: γj ≠0

It usually finds out the F-statistic which relies on the estimated model. Compare the calculated F-statistic to the analysis from the bounds table. If the value of the F-statistic is greater than the upper critical value, reject H0 (indicating a long-run determination). If the value is the lower critical value, then we do not reject H0. If it falls between the two critical values, the test is inconclusive. The critical values depend on the number of variables and the sample size of the regression analysis on the data that has been adopted to run the econometrics methodology, and they can be found in published tables from studies.

The Autoregressive Distributed Lag (ARDL) test is a statistical method followed to investigate the duration of medel in terms of long-run and short-run relationships that exist between multiple variables in multiple methodologies. It is also used as a cointegration test to get the presence of a long-run adjustment between values. In addition, it is used when we have mixed stationary data in the time series methodologies.

The Autoregressive Distributed Lag (ARDL) model formula is:

$$yt = C + B1t + p\sum i = 1\psi iyt - i + k\sum j = 1qj\sum lj$$
$$= 0\beta j, ljxj, t - lj + \epsilon t \ldots \ldots (3)$$

Where yt are the maximum findings, C is a constant variable that is static, and B1, ψ, and ʝ, lj is the majority of variation in the study that responded to with a linear trend, lags of yt and lags the k regressors xj, t for j=1, kj=1, k. Alternatively, let L showing the denotion of the lag operative entity define ψ (L and ʝ(L) Suriyanti, and Alimuddin, 2024 as the lag polynomials: and, equation (1) above can show it as:

$$\psi(L)yt = a0 + a1t + k\sum j = 1\beta j(L)xj, t + \epsilon t$$

An Error Correction Model (ECM) is a statistical model that estimates the relationship between two or more variables, taking into account the deviations from their long-run equilibrium. It's a powerful tool for analyzing and forecasting economic and financial data. The ECM combines the short-term dynamics of a vector autoregression (VAR) model with the long-run equilibrium relationships of a cointegrated system. It's based on the idea that variables usually turn away from their long-run equilibrium into short-run dynamics, but will eventually come back to it.

$$\Delta Yt = \gamma 0 + \gamma 1\Delta Xt + \lambda ut - 1 + \epsilon t \ldots \ldots (4)$$

Where:

- Δ denotes the first difference operator (e.g., $Yd = Yt - Yt - 1$)
- $\gamma 0$ is a constant term capturing short-term dynamics.
- $\gamma 1$ the short-term impact of changes
- λ is the error correction
- $ut - 1$ Error term has a lagged value from the cointegration equation, capturing the deviation from the long-term equilibrium in the lagged period.
- ϵt is the error term for the ECM.

Table 1

Variables	Abbreviation	Definition
Inflation rate	INFR	Inflation is a loss of purchasing power that reflects changes in the prices of goods and services. In addition, the inflation rate is calculated that when the average prices of a basket of selected commodities are increased over one year (Baharumshah et al., 2009).
Log of term of trade	LNTOT	The term trade shows the ratio of the country's export prices and country import prices (Malpezzi, 1999).
Log of industrial growth	LNINDG	Industrial growth is the result of demand for new products or services offered by companies in the respective fields Chenery, 1960.
Log of foreign direct investment	LNFDI	Foreign direct investment (FDI) reflects ownership that exists abroad or a project in foreign-made by a producer, company, or government from another economy (Chowdhury & Mavrotas, 2006b).
Log of exchange rate	LNER	The rate of Exchange identifies the proportion price of one currency reflected in terms of some other currency Suriyanti, and Alimuddin, 2024.
Log of gross fixed capital formation	LNGFCF	Gross fixed capital formation is calculated by the total worth of the capital of the producer, less disposals, of unchanged assets during the financial period (Williamson, 2008).
Coefficient of variables.	B0, B1, B2, B3, B4, and B5	B1, B2, B3, B4, and B5 are slopes and B0 is the intercept.

Empirical Analysis

The diagrammatical representation reflects a graphical display of data or rational data using graphs, charts plots, or visualizations to help understand and interpret the data.
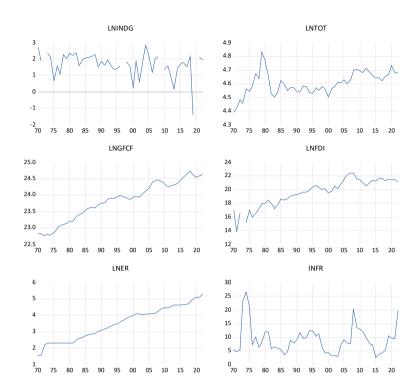
Figure 1

Table 2

RESULT OF Augmented Dicky Fuller (ADF) Test

Variables	Prob	Order of integration	Stationary
Inflation rate	0.0028*	I (0)	level
Exchange rate	0.0001**	I (1)	First difference
Foreign direct investment	0.0206**	I (1)	First difference
Gross capital formation	0.0031**	I (1)	First difference
Industrial growth	0.0368**	I (1)	First difference
Term of trade	0.0164*	I (0)	Level

Table 2. *significant at the level when the probability of variables is less than 0.05, ** significant at the first difference when the probability of variables is less than 0.05.

After testing the unit root by Augmented Dicky fuller test, it has identified that inflation rate and term of trade are stationary at a level while, gross capital accumulation, rate of exchange, foreign direct investment, and industrial growth are stationary at first difference.

Table 3

Result of Cointegration.

Variables	Coefficient	T-Values	prob
Inflation rate	-0.0798	-5.354	0.0076
Log of Exchange rate	-1.6345	-6.605	0.0006
Log of Foreign Direct Investment	0.4456	3.170	0.0193

Variables	Coefficient	T-Values	prob
Log of Gross capital formation	0.8604	2.509	0.0464
Log of Term of trade	0.318	0.549	0.622
C	-22.6567	-3.112	0.028

Table 3. The result found that the inflation rate is statistically significant because its pro is 0.007 which is less than 0.05 and its coefficient is -0.0798 which means when the inflation rate is increased by one unit the industrial growth would decrease by 0.0798. In addition, the log of the exchange rate is statistically significant and its coefficient is -1.6345 which shows that when the exchange rate increases by one percent, industrial growth would decrease by 1.6345. Moreover, the LOG of Foreign Direct Investment (LNFDI) is statistically significant and its coefficient is 0.4456 which means when LNFDI increases by one percent, the industrial growth will increase by 0.4456 percent. Next, the log of gross capital formation (LNGCF) is also statistically significant and its coefficient is 0.8604 which means when LNGCF is changed by one percent, the industrial growth would increase by 0.4456 percent. Last, the term trade has been found statistically insignificant because its probability is greater than 0.05. The overall test of significance is also found statistically significant because its value is 9.4949 which is higher than the upper level bound at 5% and 10%.

Table 4

Results Bound Test

Test-statistic	Value	Significant	I (0)	I (1)
f-statistics	9.499	10%	2.08	3
K	5	5%	2.39	3.38

Table 4. The result has found that the f-bound test is significant because the value of f-statistics is higher than the value of the upper level at 5% and 10% of the level of significance.
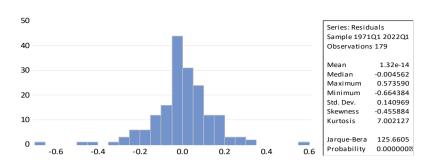
Table 5

Result of ECM

Variable	Coefficient	t-value	prob
Long run adjustment coinEq(-1)	-0.1869	-8.300	0.0000
D(LNINDG(-1)	0.7273	14.435	0.000
D(INFR	-0.041	-2.374	0.0187
D(LNTOT(-1)	-2.937	-2.3517	0.0152
D(INFR(-2)	-0.0001	-0.0323	0.9721
R-square	0.6129	Adj-R-square	0.5947

Table 5. It means that an 18% adjustment takes place quarter to quarter for a long duration. The negative sign assigned that the error is reducing after every quarter. The R-square shows that there 61% of variations exist in dependent variables LNINDG due to in-depend variables such as INFR, LNGCF, LNER, and LNFDi.

The normality test is an effective methodology of statistics that identifies the normal distribution of spreadness of the data which is an important assumption in the techniques of statistical approaches. There are a lot of tests for the distribution of normality, including the Shapiro-Wilk test, Kolmogorov-Smirnov test, Anderson-Darling test, Normality plots, and Skewness and kurtosis tests.

Test of Normality

Figure 2

Series: Residuals	
Sample 1971Q1 2022Q1	
Observations 179	
Mean	1.32e-14
Median	-0.004562
Maximum	0.573590
Minimum	-0.664384
Std. Dev.	0.140969
Skewness	-0.455884
Kurtosis	7.002127
Jarque-Bera	125.6605
Probability	0.000000

Stability Diagnostics

Stability diagnostics are statistical tools used to evaluate the stability of a statistical model or a time series data over time. The goal is to assess whether the relationships between variables or the patterns in the data remain consistent, or if there are changes or shifts that could affect the accuracy of predictions or conclusions.

Table 6

serial correlation, histogram, and heteroskedasticity test results.

Type of Test	prob
Serial correlation	0.0173
Heteroskedasticity Test: AR C H	0.0007
Histogram Normality test	0.0000

Table 6. The serial correlation has been found significant because the pro is less than 0.05. in addition, the heteroskedasticity and normality have also been found significant due to the probability being less than 0.05.

Result Discussion

Felician et al,2023) study found that the analysis long-run between FDI and the growth of industries existed. In addition, it has found a 16% long-run adjustment in the model. However, this study has found that the approaches of a long-run relationship between FDI and the growth of industries. The coefficient of FDI is 0.445 in the model. In addition, Suriyant et al,2024) the study investigates both short-run and long-run contributions between the wages of workers and industrial growth. Moreover, there is also the long-run relationship between FDI and industrial growth. This study has found the long-run relationship between FDI and industrial growth. The coefficient of FDI is 0.445 in the model. Next, regarding Preindustrial economic growth: 1270-1820, 2024) the result has shown that there is an optimistic relation and contribution between GDP growth and industrial growth. This study has found the durable approaches and their relationship between FDI and industrial growth. Furthermore, Pebble Ottoman, and Diego Japeries, 2024) the

study has derived that there is a long-run relationship between exchange rate and industrial growth in the study. This study has found that the approaches of the long time period between FDI and industrial growth. The coefficient of FDI is 0.445 in the model. Moreover, the study found that capital-flow mobility has a positive relationship with the industrial growth in the model which shows that much capital enhances production in industries in the country.

Conclusion and Policy Recommendations

The study has investigated some major outcomes from data and statistical analysis in order to contribute to and enhance the theories. Industrial growth was a dependent variable, whereas the exchange rate, inflation rate, FDI, gross fixed capital formation, and term of trade were independent variables in the analysis. The data was collected from multiple sources with the duration from 1970 to 2022. The result has found that all variables are statistically significant instead term of trade in the time series analysis. In addition, there is a negative relationship between the log of industrial growth and the log of inflation rate. The log of the exchange rate has also a negative impact on the log of industrial growth. Moreover, gross fixed capital formation has an optimistic impact on the log of

growth of industries, and the log of FDI has also the same positive impact on the log of industrial growth. The result of the long-run analysis found that the inflation rate is statistically significant because its pro is 0.007 which is less than 0.05 and its coefficient is -0.0798 which means when the inflation rate is increased by one unit the industrial growth would decrease by 0.0798. In addition, the log of the exchange rate is statistically significant and its coefficient is -1.6345 which shows that when the exchange rate increases by one percent, industrial growth decreases by 1.6345. Moreover, the LOG of Foreign Direct Investment (LNFDI) is statistically significant and its coefficient is 0.4456 which means when LNFDI increases by one percent, the industrial growth will increase by 0.4456 percent. Next, the log of gross capital formation (LNGCF) is also statistically significant and its coefficient is 0.8604 which means when LNGCF is changed by one percent, the industrial growth would increase by 0.4456 percent. Last, the term trade has been found statistically insignificant because its probability is greater than 0.05. The overall test of significance is also found statistically significant because its value is 9.4949 which is higher than the level upper bound at 5% and 10%. The ECM found that 18% adjustment takes place quarter to quarter in the long run. The negative sign shows that the error is reducing after every quarter. The R-square shows that there 61% of variations exist in dependent variables LNINDG due to independent variables such as INFR, LNGCF, LNER, and LNFDi. The revolution of industries are major and important key factor that should be dominated in the underdeveloping economies that are the cause of upraising the tactics and phenomena to reach the developed pattern. Furthermore, getting

capital welfare is a very important achievement not only to get welfare but also to get sustainable rewards in the economy same as in Pakistan. Social, and environmental stability can be achieved by getting capital welfare in the growing economy.

A Pragmatic Approach to Trade Agreements renegotiate existing trade agreements to ensure preferential access for value-added items and consider the impact on tax revenues and jobs. In addition, Investments from abroad Focus on the substitution of imported commodities, commodities exports, advanced technology, and capital modernization sectors. Moreover, Corporatization & Consolidation are the tools to Promote the formation of corporates, improve governance standards, and encourage consolidation through Holding Companies and Group Relief. A Trained and Productive Workforce enhances valuable skills through capital partnerships and allows profit approaches to maintain and expand workforce development funds. Furthermore, Small and Medium Enterprises address transaction costs, increase access to credit, and promote SME integration into larger value chains. Rethink Industrial Policy focuses on improving economic complexity, promoting value-added exports, and encouraging import substitution. Besides, Short-term Goals Sensitize industries to new technologies, target high-potential areas like the textile sector and promote export promotion. Medium-Term Goals Upgrade and develop ICT infrastructure, enhance productivity, and explore opportunities in the dairy sector. Long-Term Goals Support R&D initiatives, connect research to production and foster collaboration between universities, research institutes, and industry.

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