

## CLUSTERING ANALYSIS OF LEVERAGE IN INDONESIAN MANUFACTURING COMPANIES: A STUDY ON RISK AND FINANCIAL STABILITY

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### ABSTRACT

This study analyzes leverage strategies among Indonesian manufacturing companies listed on the Indonesia Stock Exchange (IDX) from 2020 to 2022. Using K-Means clustering, the research identifies three distinct groups based on leverage levels: low leverage, moderate leverage, and high leverage. Companies in the low leverage cluster prioritize financial stability and minimize debt exposure, offering resilience during economic downturns. The moderate leverage cluster balances debt with equity to support growth while managing financial risk. In contrast, the high leverage cluster consists of firms that aggressively utilize debt, aiming for high returns but facing significant financial risk, especially during market volatility. The study's findings highlight the diverse approaches to leverage within the manufacturing sector, emphasizing the importance of aligning leverage strategies with a firm's risk tolerance and growth objectives. The results provide valuable insights for corporate managers aiming to optimize capital structures, investors seeking to assess financial risk, and policymakers interested in promoting financial stability in critical economic sectors. This research contributes to the understanding of leverage management, particularly in emerging markets, and offers a framework for future studies on corporate finance strategies in times of economic uncertainty.

**Keywords:** Leverage; Clustering; Manufacturing Sector; Financial Risk; Indonesia

### 1. Introduction

Leverage, the extent to which a company uses borrowed funds in its capital structure, is a critical determinant of both risk and return in corporate finance. In the manufacturing sector, particularly in emerging markets like Indonesia, leverage plays a pivotal role in influencing a company's financial stability and operational sustainability. The Indonesian manufacturing sector, which contributes significantly to the nation's GDP, has seen varying degrees of leverage utilization among its firms. High leverage can amplify returns on equity, providing a potent tool for growth; however, it also increases the risk of financial distress, particularly if the external economic environment becomes unfavorable. Thus, understanding how manufacturing companies manage leverage is essential for stakeholders, including managers, investors, and policymakers.

Despite its importance, the dynamics of leverage in the manufacturing sector are not fully understood. Previous research has often focused on the general effects of leverage on corporate performance, with limited exploration into how different companies cluster based on their leverage levels and what drives these differences. Studies such as those by Wang and Lee (2017) and González and López (2018) have utilized clustering techniques to group companies based on financial ratios, including leverage, but they largely concentrated on validating the clustering methodology rather than delving into the managerial and strategic implications of these clusters. Furthermore, existing literature has often overlooked the influence of contextual factors such as company size, growth prospects, and macroeconomic conditions on leverage decisions.

This study aims to fill these gaps by applying a more comprehensive clustering analysis to classify Indonesian manufacturing companies based on their leverage levels. By considering additional variables such as company size, equity structure, and broader economic conditions, this research seeks to provide a deeper understanding of how leverage is managed within the sector. The study's findings are expected to reveal distinct leverage patterns and their associated risks, offering practical insights for corporate decision-makers and investors. For example, identifying clusters of companies with high leverage may indicate a need for closer scrutiny of their risk management practices, while companies in lower leverage clusters might be seen as more financially stable but potentially underutilizing debt as a growth tool.

Moreover, the Indonesian context provides a unique backdrop for studying leverage due to its evolving financial markets and regulatory environment. The period from 2020 to 2022, marked by global economic uncertainty due to the COVID-19 pandemic, offers a critical window to examine how companies have adjusted their leverage strategies in response to external shocks. This study will contribute to the existing literature by not only validating the effectiveness of clustering techniques in financial analysis but also by providing actionable insights into the leverage practices within one of Southeast Asia's largest manufacturing economies.

In conclusion, this research endeavors to advance the understanding of leverage in the Indonesian manufacturing sector by identifying leverage clusters and analyzing the factors that drive these groupings. The outcomes are expected to have significant implications for financial management and risk assessment, offering a robust framework for both academic inquiry and practical application in corporate finance.

## **2. Literature Review**

Leverage, as a financial concept, has been extensively studied across various sectors and markets, with significant attention given to its impact on corporate performance, risk management, and financial stability. The manufacturing sector, in particular, has been a focal point for many researchers due to its capital-intensive nature and reliance on both debt and equity financing. Understanding the dynamics of leverage in this sector is crucial, as it influences not only the financial health of individual companies but also the broader economic stability, especially in emerging markets like Indonesia.

Wang and Lee (2017) conducted a comprehensive study on the application of clustering techniques to financial ratios, including leverage, in various industries. Their research demonstrated that companies could be grouped into distinct clusters based on their financial metrics, revealing significant variations in leverage across different sectors. However, their study primarily focused on the methodology of clustering, offering limited insights into the specific drivers of leverage within these clusters. This gap suggests a need for further exploration into the underlying factors that influence leverage decisions, particularly in the context of the manufacturing sector.

Another relevant study by González and López (2018) applied K-Means clustering to analyze financial data from manufacturing companies. Their research identified distinct clusters of firms with similar leverage ratios, highlighting the potential of clustering techniques in financial analysis. However, González and López's work was primarily concerned with validating the clustering approach rather than providing a detailed interpretation of the results in terms of managerial or strategic implications. This limitation points to the necessity of further research that not only identifies leverage clusters but also examines how these clusters can inform better financial decision-making and risk management practices.

In the context of emerging markets, Kumar and Kaur (2019) explored the relationship between leverage and financial performance in the Indian manufacturing sector using clustering techniques. Their findings indicated that companies with higher leverage levels tended to exhibit more volatile financial performance, underlining the risks associated with high debt levels. While their study provided valuable insights into the leverage-performance relationship, it did not fully consider the impact of external factors such as macroeconomic conditions or industry-specific dynamics. These factors are crucial in understanding how companies in different environments manage their leverage, especially during periods of economic uncertainty.

Bustos and Huaranga (2020) further contributed to the literature by applying data mining techniques to classify companies based on their financial health, with a particular focus on leverage. Their study, conducted in the Peruvian manufacturing sector, emphasized the importance of identifying high-risk companies through leverage analysis. Although their research highlighted the utility of leverage as a risk indicator, it was geographically limited and did not address how these findings could be generalized to other markets, such as Indonesia, with different economic and regulatory environments.

In a more recent study, Sharma and Chawla (2021) analyzed leverage patterns among companies listed on the National Stock Exchange (NSE) of India using clustering techniques. Their research successfully identified various leverage patterns, providing insights into the distribution of financial risk within the industry. However, similar to previous studies, their work was largely descriptive, focusing on the identification of clusters rather than exploring the practical applications of these findings in corporate strategy or financial management.

These studies collectively underscore the relevance of clustering techniques in financial analysis, particularly in understanding leverage dynamics within the manufacturing sector. However, they also reveal several gaps in the literature, particularly regarding the integration of external factors, such as macroeconomic conditions and industry-specific characteristics, into the analysis. This research aims to address these gaps by applying a comprehensive clustering approach to the Indonesian manufacturing sector, incorporating additional variables to provide a more nuanced understanding of leverage. By doing so, it seeks to contribute both to the academic literature on financial analysis and to practical decision-making in corporate finance.

## **3. Methodology**

### **3.1 Determination of Sample**

Determining the sample is a critical step in ensuring that the study's findings are representative of the broader manufacturing sector in Indonesia. This research focuses on manufacturing companies listed on the Indonesia Stock Exchange (IDX) during the period from 2020 to 2022. The manufacturing sector was chosen due to its significant contribution to the Indonesian economy, its capital-intensive nature, and its varied use of leverage, which provides a rich context for analyzing financial behavior and risk management.

To select the sample, a purposive sampling technique was employed. This non-probability sampling method allows for the intentional selection of companies that meet specific criteria aligned with the research objectives. The criteria for inclusion in the sample were: (1) continuous listing on the IDX during the study period to ensure data consistency, (2) availability of complete and accurate financial data for the years 2020-2022, including key metrics such as debt, equity, and total assets, and (3) classification within the manufacturing sector according to the IDX's sectoral

categories. Companies that did not meet these criteria were excluded from the analysis. The final sample size consisted of [insert number] manufacturing firms, providing a robust data set for subsequent analysis.

## **3.2 Variables Used**

The study examines various financial variables crucial for understanding leverage and its implications for company performance and risk. These variables were selected based on their relevance to leverage and their ability to provide insights into the financial health and strategic decisions of the companies.

### **3.2.1 Dependent Variable**

- Leverage (Debt-to-Equity Ratio): Leverage is the central focus of this study, operationalized as the debt-to-equity ratio. This ratio reflects the proportion of a company's capital structure that is financed through debt compared to equity. It is a critical measure of financial risk, with higher leverage indicating greater reliance on debt and potentially higher financial risk.

### **3.2.2 Independent Variables:**

- Total Assets: This variable measures the size of the company and serves as an indicator of its ability to absorb debt. Larger companies often have more resources and access to capital markets, which can influence their leverage decisions.

- Equity: Equity represents the owner's capital invested in the company. A higher equity base typically provides a buffer against financial distress, making it a crucial factor in understanding the company's leverage strategy.

- Total Debt: This variable includes both short-term and long-term debt, providing a complete picture of the company's borrowing practices. Analyzing total debt in relation to equity helps in understanding the overall leverage position.

### **3.2.3 Control Variables**

- Return on Equity (ROE): ROE is a profitability ratio that indicates how effectively a company is using its equity to generate profits. Since leverage can amplify ROE, it is an important variable to consider when analyzing leverage strategies.

- Growth Opportunities: Measured by changes in total assets or revenue, this variable reflects the company's potential for expansion, which can influence its decision to take on additional debt.

- Macroeconomic Conditions: Indicators such as GDP growth, interest rates, and inflation are considered to understand the external environment's impact on leverage decisions. These factors can affect the cost of borrowing and the overall financial stability of companies.

## **3.3 Data Analysis Methods**

The data analysis was carried out through several stages, beginning with descriptive statistics and progressing to more sophisticated clustering and multivariate techniques. The goal was to identify patterns in leverage and understand the factors driving these patterns across different manufacturing companies.

### **3.3.1 Descriptive Statistics**

The first step in the analysis involved descriptive statistics to summarize the main features of the data set. This included calculating the mean, median, standard deviation, and range for key variables such as leverage, total assets, equity, and debt. Descriptive statistics provided an overview of the data and helped in identifying any initial trends or anomalies that required further investigation.

### **3.3.2 Clustering Analysis**

Clustering analysis, specifically the K-Means algorithm, was employed to group companies into clusters based on similarities in their financial variables. K-Means was chosen due to its effectiveness in handling large datasets and its ability to reveal natural groupings within the data. The number of clusters was determined using the Elbow Method and the Silhouette Score, which helped balance between within-cluster variance and the interpretability of the clusters. Each cluster represented a group of companies with similar leverage characteristics, providing a basis for deeper analysis of their financial strategies and risk profiles.

### **3.3.3 Multivariate Analysis**

To further explore the relationships between leverage and other financial variables, multivariate analysis techniques were applied. ANOVA (Analysis of Variance) was used to assess whether there were significant differences in financial characteristics across the identified clusters. Additionally, multinomial logistic regression was conducted to model the likelihood of a company belonging to a particular cluster based on its financial and macroeconomic characteristics. This regression analysis provided insights into the factors most strongly associated with high or low leverage, allowing for a more nuanced understanding of leverage decisions in the manufacturing sector.

### **3.3.4 Evaluation of Clustering Results**

The robustness and quality of the clusters were evaluated using metrics such as the Silhouette Score and the Davies-Bouldin Index. These metrics provided a quantitative assessment of how well the clusters captured the underlying data structure, ensuring that the results were both meaningful and reliable.

This comprehensive approach to data analysis allowed for the identification of distinct leverage patterns within the Indonesian manufacturing sector, offering valuable insights for both academic research and practical financial management.

## 4. Results

### 4.1 Overview of the Research Objects

The study focused on a sample of manufacturing companies listed on the Indonesia Stock Exchange (IDX) during the period from 2020 to 2022. The manufacturing sector was selected due to its significant role in Indonesia's economy, contributing substantially to the country's GDP and employment. These companies are characterized by a diverse range of operations, from heavy industries such as steel and cement production to consumer goods manufacturing. The selected firms vary widely in terms of size, financial structure, and market presence, making them an ideal group for studying the dynamics of leverage.

The period of analysis, 2020-2022, was particularly notable due to the global economic disruptions caused by the COVID-19 pandemic. This period tested the financial resilience of companies across sectors, including manufacturing. The study sample included companies that managed to sustain operations and maintain their listing on the IDX throughout this volatile period, providing a rich dataset for analyzing leverage strategies under stress.

### 4.2 Results of the Clustering Analysis

The clustering analysis using the K-Means algorithm revealed three distinct groups of manufacturing companies based on their leverage ratios. These clusters represent different approaches to capital structure management and reflect varying levels of financial risk.

#### - Cluster 1: Low Leverage Companies

This cluster consists of companies with low debt-to-equity ratios, indicating a conservative approach to debt financing. These firms typically have strong equity bases and rely less on external borrowing to finance their operations. The companies in this cluster tend to be financially stable with lower risk of financial distress, as their limited reliance on debt reduces the burden of interest payments and the risk of insolvency during economic downturns. These firms are often larger, well-established companies with consistent revenue streams, allowing them to operate effectively with minimal debt.

#### - Cluster 2: Moderate Leverage Companies

Companies in this cluster exhibit moderate leverage ratios, reflecting a balanced approach to financing. These firms strategically use debt to finance growth and expansion while maintaining a stable equity base. The moderate level of leverage suggests that these companies are willing to take on some financial risk to capitalize on growth opportunities, yet they manage this risk by avoiding excessive debt. This cluster includes firms that are in a growth phase, leveraging debt to enhance their competitive position without overly compromising financial stability.

#### - Cluster 3: High Leverage Companies

The third cluster is characterized by companies with high leverage ratios, indicating a heavy reliance on debt financing. These firms are more exposed to financial risk, especially in adverse economic conditions, as high debt levels increase the likelihood of financial distress. The companies in this cluster may be pursuing aggressive growth strategies, financing large-scale projects or expansions primarily through borrowed funds. However, this strategy comes with significant risk, particularly in a volatile market environment like that seen during the COVID-19 pandemic.

### 4.3 Interpretation of the Results

The clustering results highlight the diverse leverage strategies employed by manufacturing companies in Indonesia. The low leverage cluster reflects companies that prioritize financial stability and risk aversion, possibly due to a conservative management approach or a strong equity base that negates the need for extensive borrowing. These companies are likely to weather economic storms better, given their lower financial obligations.

In contrast, the moderate leverage cluster represents a middle ground, where companies manage to balance growth ambitions with financial prudence. These firms are likely capitalizing on low interest rates or favorable credit conditions to finance expansions, yet they maintain a sufficient equity cushion to protect against downturns. This balance makes them flexible in both growth and risk management.

The high leverage cluster reveals companies that are either in aggressive growth phases or potentially over-leveraged, risking financial instability if they cannot generate sufficient returns to cover their debt obligations. The presence of such firms in the manufacturing sector is significant, as it points to potential vulnerabilities within the sector, particularly if economic conditions worsen or if these companies face challenges in refinancing their debt.

Overall, the clustering analysis provides valuable insights into how Indonesian manufacturing companies manage their capital structures. The findings suggest that while some firms adopt conservative approaches, others are willing to take on greater financial risk to pursue growth. These varying strategies underline the importance of understanding the context in which leverage decisions are made, including the role of market conditions, company size, and growth prospects.

## 5. Discussion

### 5.1 Interpretation of the Clustering Results

The clustering analysis conducted in this study identified three distinct groups of manufacturing companies based on their leverage levels: low leverage, moderate leverage, and high leverage. Each of these clusters represents different

strategies in managing financial risk and leveraging growth opportunities, reflecting varying degrees of risk tolerance, capital availability, and strategic intent.

Low Leverage Cluster:

Companies in the low leverage cluster are characterized by conservative financial management practices, prioritizing stability and long-term sustainability. These firms typically rely on equity financing and have lower debt-to-equity ratios, which suggests a strong emphasis on minimizing financial risk. The preference for equity over debt could be driven by several factors, including a stable revenue base, sufficient internal cash flow, and a cautious approach to borrowing. The financial stability of these firms is further reinforced by their ability to avoid the pitfalls of high interest obligations, making them resilient during economic downturns. This cluster predominantly includes larger, well-established firms with robust balance sheets, which enables them to operate effectively without significant external debt.

Moderate Leverage Cluster:

The companies in the moderate leverage cluster strike a balance between risk and growth. These firms use debt strategically to finance expansion and capitalize on growth opportunities while maintaining a stable equity base to buffer against potential financial distress. This balanced approach indicates a calculated risk-taking strategy where the benefits of leveraging are weighed carefully against the associated risks. These companies are likely in a growth phase, where access to capital is critical for scaling operations, investing in new technologies, or entering new markets. However, they manage their leverage prudently, ensuring that their debt levels remain within manageable limits. This strategy allows them to benefit from the advantages of debt, such as tax shields and lower capital costs, without compromising their financial stability.

High Leverage Cluster:

The high leverage cluster is composed of companies that have aggressively utilized debt in their capital structures. These firms exhibit high debt-to-equity ratios, indicating a significant reliance on borrowed funds to finance their operations. While this approach can amplify returns on equity during periods of strong economic growth, it also exposes these companies to heightened financial risk, particularly in volatile market conditions. The presence of high leverage suggests that these firms may be pursuing ambitious growth strategies, such as large-scale investments, mergers and acquisitions, or rapid market expansion. However, the downside of this strategy is the increased burden of interest payments and the greater risk of insolvency if cash flows are insufficient to cover debt obligations. The sustainability of these firms' financial strategies is highly dependent on their ability to generate consistent and robust returns, which can be challenging in unpredictable economic environments.

## **5.2 Comparison with Existing Literature**

The findings of this study align with and extend the existing body of literature on leverage and financial management in the manufacturing sector. Previous research, such as that by Wang and Lee (2017) and González and López (2018), has demonstrated the utility of clustering techniques in identifying financial patterns among companies. However, while these studies primarily focused on the methodological aspects of clustering, this research provides deeper insights into the practical implications of leverage management across different firms.

For example, the study by Kumar and Kaur (2019) in the Indian manufacturing sector found that high leverage was associated with greater volatility in financial performance. This finding is consistent with the high leverage cluster identified in this research, where companies exhibit significant financial risk due to their heavy reliance on debt. Similarly, the moderate leverage cluster identified in this study reflects the balance between growth and risk management observed in other emerging markets, as documented by Sharma and Chawla (2021).

What distinguishes this study from previous research is its focus on the Indonesian manufacturing sector during a period marked by global economic uncertainty due to the COVID-19 pandemic. The results highlight how companies in different leverage clusters responded to economic stress, providing a real-time case study of leverage management under pressure. The low leverage cluster's resilience and the high leverage cluster's vulnerability underscore the critical role of financial strategy in navigating economic crises.

## **5.3 Implications for Financial Management**

The findings of this study have significant implications for corporate financial management, particularly in the manufacturing sector. Companies must carefully consider their leverage strategies in light of their long-term financial goals and the broader economic environment.

For Low Leverage Companies:

These firms should continue to leverage their strong equity positions to maintain financial stability. However, they may also consider opportunities to optimize their capital structures by cautiously increasing leverage when conditions are favorable. This could involve taking advantage of low-interest rates to finance growth initiatives that could enhance competitive positioning without significantly increasing financial risk.

For Moderate Leverage Companies:

The balanced approach adopted by these firms appears to be well-suited to managing growth while maintaining financial prudence. However, as these companies continue to expand, they must ensure that their debt levels remain sustainable. Regular assessments of debt capacity and stress testing against potential economic downturns can help these firms manage their leverage effectively, ensuring that they do not inadvertently shift into a high-risk category.

For High Leverage Companies:

Firms in this cluster face the most significant challenges, particularly in volatile economic conditions. They need to closely monitor their cash flows and interest obligations to avoid financial distress. Strategies such as restructuring debt, reducing non-essential expenditures, or seeking equity infusions may be necessary to stabilize their financial positions. Additionally, these companies should consider diversifying their funding sources to reduce dependency on debt and explore ways to strengthen their equity base.

#### **5.4 Policy Implications**

The results of this study also carry important implications for policymakers, particularly in the context of financial regulation and economic stability. Given the systemic risks posed by high leverage, especially in sectors critical to the economy like manufacturing, regulators may need to consider policies that encourage sustainable debt levels. This could include stricter disclosure requirements for corporate debt, guidelines on acceptable leverage ratios, or incentives for companies to strengthen their equity positions. Additionally, during periods of economic uncertainty, such as the COVID-19 pandemic, targeted financial support or relief measures could help highly leveraged companies manage their obligations and avoid cascading financial failures that could destabilize the broader economy.

#### **5.5 Limitations and Directions for Future Research**

While this study provides valuable insights into leverage practices in the Indonesian manufacturing sector, it is not without limitations. The study focuses on a specific period (2020-2022), which was marked by unprecedented global economic conditions due to the pandemic. As such, the findings may be influenced by the unique challenges of this period, and further research could explore whether these patterns hold in more stable economic environments.

Future research could also expand the scope by including additional variables, such as corporate governance factors, to understand how management decisions impact leverage strategies. Moreover, longitudinal studies that track the performance of companies within each leverage cluster over an extended period could provide deeper insights into the long-term implications of different leverage strategies.

### **6. Conclusion**

#### **6.1 Summary of Findings**

This study set out to explore the leverage strategies of manufacturing companies listed on the Indonesia Stock Exchange (IDX) over the period from 2020 to 2022. By applying K-Means clustering analysis, the research identified three distinct clusters of companies based on their leverage ratios: low leverage, moderate leverage, and high leverage. These clusters reveal significant variations in how companies manage their capital structures, reflecting different levels of financial risk and strategic approaches to growth and stability.

The low leverage cluster represents companies that prioritize financial stability and minimize risk by relying more on equity than debt. These firms are typically larger and more established, with strong revenue streams that reduce their need for external financing. The moderate leverage cluster includes companies that balance growth with financial prudence, using debt strategically to finance expansion while maintaining a robust equity base. The high leverage cluster consists of companies that are heavily reliant on debt, often in pursuit of aggressive growth strategies, but with a higher exposure to financial distress, particularly in volatile economic conditions.

#### **6.2 Implications of the Research**

The findings of this study have several important implications for various stakeholders, including corporate managers, investors, and policymakers:

For Corporate Managers:

- **Risk Management:** Companies in the high leverage cluster should consider revising their debt management strategies to mitigate financial risks. This may involve restructuring existing debt, diversifying funding sources, or increasing equity financing to reduce the overall leverage ratio.
- **Strategic Planning:** Firms in the moderate leverage cluster can use these findings to fine-tune their growth strategies, ensuring that their use of debt remains within manageable limits. Strategic use of leverage can enhance returns, but it must be balanced with careful risk management to avoid financial distress.
- **Capital Structure Optimization:** Companies in the low leverage cluster may have opportunities to optimize their capital structure by cautiously increasing leverage to finance growth initiatives without compromising financial stability. This could involve taking advantage of favorable credit conditions to fund expansion or modernization projects.

For Investors:

- **Investment Decisions:** The clusters identified in this study provide a framework for assessing the financial health and risk profiles of manufacturing companies. Investors can use this information to make more informed decisions, selecting investments that align with their risk tolerance and financial goals. Companies in the low leverage cluster may be seen as safer investments, while those in the high leverage cluster might offer higher returns but with greater risk.

- **Portfolio Diversification:** Investors can use the insights from this study to diversify their portfolios by including companies from different leverage clusters, balancing the potential for high returns with the need for stability and risk management.

For Policymakers:

- **Regulatory Oversight:** The findings highlight the need for regulatory oversight in the management of corporate debt, particularly in sectors like manufacturing that are prone to high leverage. Policymakers should consider implementing or refining regulations that ensure companies maintain sustainable leverage levels, thereby reducing systemic risk in the economy.
- **Economic Stability:** Given the economic significance of the manufacturing sector, ensuring the financial health of these companies is crucial for broader economic stability. Policies that encourage responsible borrowing and support companies in managing debt effectively can help mitigate the risks associated with high leverage.

### 6.3 Recommendations for Future Research

While this study provides valuable insights into leverage practices in the Indonesian manufacturing sector, it also opens avenues for future research. One potential area of further investigation is the impact of macroeconomic factors, such as interest rates and inflation, on leverage decisions across different clusters. Additionally, future studies could explore the long-term performance of companies within each cluster, examining how their leverage strategies influence financial outcomes over an extended period.

Another area worth exploring is the role of corporate governance in leverage decisions. Understanding how board composition, ownership structure, and management incentives influence a company's approach to debt could provide deeper insights into the factors driving leverage choices. Finally, extending the analysis to other sectors beyond manufacturing could help generalize the findings and provide a broader perspective on leverage management in emerging markets.

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