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Journal of Management, Accounting, General Finance and International Economic Issues
https://ojs.transpublika.com/index.php/MARGINAL
Online ISSN 2809-8013 | Print ISSN 2809-9222

https://doi.org/10.55047/marginal.v4i1.1529

Measuring Economic Contribution and Per Capita Income Disparities in Indonesia Using the Theil Index

Original Article

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Received : 17 November - 2024
Accepted : 23 December - 2024
Published online : 25 December - 2024

Abstract

This study aims to analyze economic contribution and per capita income disparities among provinces in Indonesia using the Theil Index method. The results indicate that the total economic contribution disparity among provinces has a value of 2.2716, with the intra-island disparity (T_{intra}) component accounting for 1.4919 and the inter-island disparity (T_{inter}) component accounting for 1.2237. Meanwhile, the analysis of per capita income disparity shows a Total Theil Index of 0.8520, with the T_{intra} component accounting for 0.8384 and the T_{inter} component accounting for 0.0136. These findings highlight that intra-island disparities play a more dominant role than inter-island disparities. Therefore, policies focused on equitable infrastructure development in remote areas and the acceleration of development in eastern Indonesia are essential to reduce these disparities. This study also recommends that further research should be conducted to explore the factors contributing to these disparities.

Keywords: Economic Inequality, Per Capita Income Disparity, Theil Index, Tintra, Tinter.

1. Introduction

Economic development in a region is a systematic effort to enhance the capacity and performance of an area to generate the welfare of its people through sustainable economic growth. According to (Barros, 2022), economic development encompasses not just income growth but also structural transformation involving the modernization of economic sectors and the reduction of interregional disparities. This process aims to improve people's quality of life by creating equitable economic opportunities.

Inclusive economic growth is essential for shared welfare. Kuznets (1955) argues that economic development is not solely about the increase in GDP but also about the fair distribution of the benefits of that growth. High inequality can hinder social and political development while fostering economic instability. Therefore, equitable income distribution is fundamental for ensuring the sustainability of development.

From a spatial perspective, economic disparities are difficult to avoid due to differences in natural resource potential, accessibility to infrastructure, and human capital quality. Geographic factors, such as strategic locations or the availability of natural resources, often determine a region's ability to develop. McCann & Van Oort (2019), in his economic geography theory, emphasizes that economic activity tends to concentrate in specific regions due to agglomeration and economies of scale.

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In Indonesia, the initial phase of economic development was heavily centralized during the era of central planning, with the central government controlling most resources and development policies. However, with the implementation of regional autonomy in 2001, regional governments were granted greater authority to manage their own economic development. This shift allowed regions to explore their unique local potential and foster more targeted economic growth. Decentralization has provided each region with opportunities to grow at its own pace, based on local conditions and needs. This authority enables regional governments to design tailored development policies such as optimizing natural resource use, improving infrastructure, and enhancing human capital quality.

Indonesia, consisting of 38 provinces, possesses diverse natural resources, ranging from mineral resources in Kalimantan to agricultural production in Java and fisheries in Sulawesi. This diversity creates both challenges and opportunities for fostering inclusive economic development across the country's various regions (Badan Pusat Statistik (BPS), 2023). As an archipelagic nation stretching from Sabang to Merauke, Indonesia has unique spatial characteristics. The geographical layout of thousands of islands leads to disparities in resource access, infrastructure development, and economic growth across regions. Each island has its unique resource advantages, such as abundant natural resources, opportunities in ocean-based industries, and strengths in agriculture and mining. However, disparities between islands and provinces remain a barrier to equitable welfare and economic progress. Therefore, comprehensive analysis is essential to understand economic disparities and income gaps across provinces and islands (Resosudarmo & Vidyattama, 2006).

The National Development Planning Agency (Bappenas) has divided Indonesia into six major regions based on islands: Sumatra, Java, Kalimantan, Sulawesi, Bali-Nusa Tenggara, and Maluku-Papua. This division facilitates economic analysis because each region has unique characteristics related to resources, demographics, and infrastructure.

The economic contribution of each island to Indonesia's economy varies (Wahyuningrum & Juliprijanto, 2022). Java, for example, serves as the center of industry and services with the highest contribution to the national GDP. Kalimantan dominates the extractive sector, including mining and oil. Bali-Nusa Tenggara relies heavily on tourism, while Maluku-Papua has significant potential in mining and fisheries.

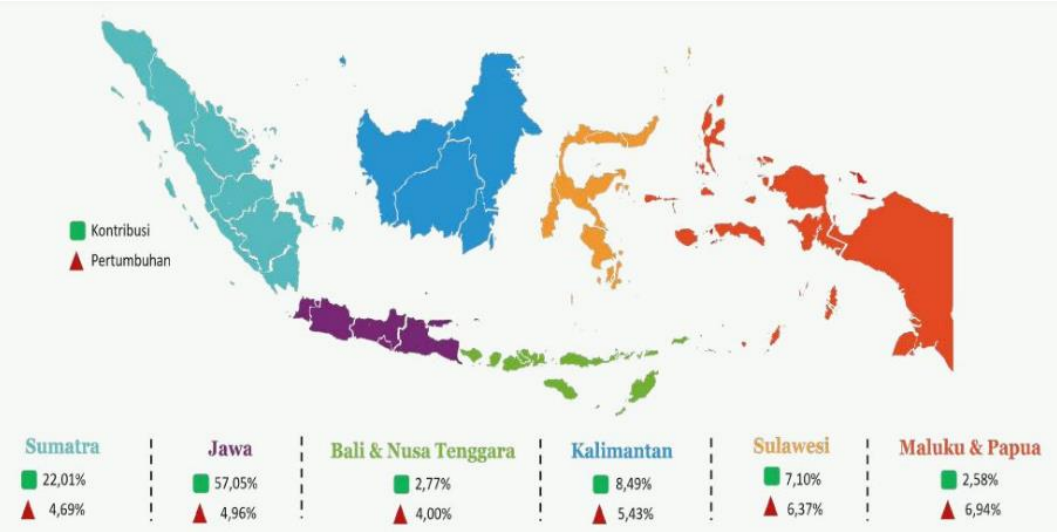

Figure 1. Economic Growth and GDP Contribution by Island in Indonesia, 2023
Sources: BPS (2023)

As shown in Figure 1, disparities in economic contribution and growth exist across these regions. To address these disparities, Bappenas has implemented several strategic programs, as outlined in the RPJPN 2025–2045, aimed at improving access and opportunities for economic development across Indonesia. These programs include strengthening infrastructure, increasing access to education and skill development, supporting community-based enterprises, and improving interregional connectivity to support equitable distribution of resources and investments. Through these policies, Bappenas seeks to reduce regional development disparities and ensure equitable prosperity across Indonesia (Bappenas, 2023).

Various inequalities in economic contribution and per capita income among major islands in Indonesia highlight the urgent need for serious attention in addressing development gaps (Kurniawati & Islami, 2022). These inequalities have implications for the uneven distribution of resources and affect the population's access to sustainable well-being. Therefore, to understand the complexity of these inequalities, an in-depth analysis using a spatial approach with the Theil Index as an analytical tool is necessary.

The objectives of this study are first, to examine economic contribution inequalities among major islands in Indonesia using the Theil Index. Second, to evaluate per capita income inequalities among major islands in Indonesia using the same approach. By understanding these two objectives, this study aims to provide a more comprehensive picture of economic distribution and well-being across the islands of Indonesia, as well as to support the formulation of more inclusive and equitable development policies.

This research represents an initial stage of a broader research program on the spatial aspects of economic inequality and economic convergence, designed to provide deeper insights into Indonesia's economic growth and equitable development in the future.

2. Literature Review

2.1. Measurement of Economic Development Inequality

Measuring economic inequality is a crucial aspect in evaluating the distribution of wealth and resources among individuals, groups, or regions. One of the most widely used approaches to measure this inequality is through the use of the Theil Index. The Theil Index was first introduced by Theil & Uribe (1967) and is capable of measuring disparities both among individuals and between regions based on income distribution or economic contributions (Cowell, 2003).

The Theil Index comprises two main components: Tinter and Tintra. *Tinter* measures inequality between groups or across different regions, while *Tintra* assesses inequality within a specific group or within the same geographical area. By combining these two components, the total inequality (Ttotal) can be computed, providing a comprehensive overview of the extent of inequality in a particular area or country (Cao & Tao, 2024).

The spatial approach in this measurement also enables the study of the geographical factors' influence on economic disparities. Factors such as geographical location, infrastructure, natural resource distribution, and regional policies can lead to significant economic disparities. Therefore, by employing spatial analysis based on the Theil Index, it becomes possible to assess inequality patterns influenced by geographic characteristics and development policies. Previous studies have frequently utilized spatial analysis with the Theil method to understand the dynamics of regional inequalities across various economic contexts (Gezici & Hewings, 2007).

Previous research has demonstrated that this approach can uncover the factors contributing to regional disparities, whether related to income or economic contribution,

thereby assisting in the formulation of more inclusive and equitable development policies (Leigh, 2024). Therefore, this approach is relevant for studies aiming to understand economic contribution inequalities among Indonesia's major islands and income disparities per capita using a spatial approach with the Theil Index.

2.2. Inequality in Indonesia: An Empirical Study

Numerous studies have been conducted to examine economic inequality in Indonesia. (Ginanjar et al., 2024) utilized the Theil Index to analyze inter-provincial inequalities across Indonesia and discovered that inter-regional inequality is more dominant than intra-regional inequality. Their findings highlight the significant disparities in economic contributions between regions.

Another study by (Mona & Agustina, 2022) indicated that inter-regional disparities in Indonesia are largely driven by inequalities in infrastructure development and the concentration of economic activity in Java. This suggests that the uneven distribution of development opportunities contributes significantly to regional disparities.

Ramadhan et al. (2024) conducted a study on inter-provincial economic contribution disparities in Indonesia using the Theil Index as their analytical tool. The results of their study showed that Java continues to dominate the national economic contribution, accounting for approximately 58%, while other provinces contribute much less. This study further emphasized that inter-provincial inequalities in Indonesia are influenced by multiple factors, including unequal access to infrastructure, market opportunities, and resource allocation.

3. Methods

3.1. Research Design

This study employs a quantitative approach with secondary data analysis to examine economic development disparities among six major islands in Indonesia: Sumatra, Java, Kalimantan, Sulawesi, Bali-Nusa Tenggara, and Maluku-Papua. The research focuses on analyzing economic and welfare inequalities across these major islands in Indonesia using the Theil Index.

The data analyzed in this study includes economic contribution data (regional GDP) and per capita income. The primary data source is obtained from the Badan Pusat Statistik (BPS), which is the official national statistical agency providing information related to inter-provincial economic contributions and income distribution. This ensures the data's reliability and comprehensiveness for conducting the analysis.

Operationalization of Research Variables

a) Provincial Income (Yp): Total income of the province.
b) Provincial Per Capita Income (Ypp): The average income per individual in a province.
c) Provincial Population (np): Total population within a province.
d) Total Island Income (Yi): The total income of all provinces within a specific island.
e) Island Per Capita Income (Ypi): The average income per individual on an island.
f) Island Population (ni): Total population on a specific island.
g) National Income (YN): The total income of all provinces across Indonesia.
h) National Per Capita Income (YpN): The average income per individual in Indonesia.
i) Total Population of Indonesia (nN): The total population of Indonesia.

3.2. Data Analysis

3.2.1. Analysis of Economic Contribution Inequality Across Major Islands in Indonesia Using Theil Index

The Theil Index is selected to measure the level of economic development inequality based on economic contribution. This index allows for the decomposition of inequalities into intra-group (within the same island) and inter-group (between islands) components.

1. Intra-Group Inequality (Within-Island Inequality): This measures inequality across provinces within each major island.
   T_{intra} (within-island inequality): Represents disparities in economic contribution across the provinces in a single major island.

$$T_p = \sum \left(\frac{Y_p}{Y_i} \; x \; ln \left(\frac{Y_p}{Y_i} \right) \right)$$

   Variable Explanation:
   Tp = Theil Index for within-island inequality
   Yp = Total income of the province within the island
   Yi = Total income of all provinces within the same island

   Formula Theil Index for Total Within-Island Inequality

$$T_{Intra} = \sum_{p=1}^{P} \frac{Y_p}{Y_i} Tp$$

2. Inter-Group Inequality (Between-Region Inequality)
   The inequality among the six major islands in Indonesia is measured using the Theil Index between islands (T_{Inter}). The formula for T_{Inter} is as follows:

$$T_{Inter} = \sum_{p=1}^{P} \frac{Y_i}{Y_N} \; x \; ln \; \frac{Y_i}{Y_N}$$

   Variable Explanation:
   T_{Inter} = Theil Index between islands
   Y_i = GDP of the island group iii
   Y_N = National total GDP
   ln = Natural logarithm function

   After calculating T_{Intra} (within-island inequality) and T_{Inter} (between-island inequality), we can calculate T_{Total} (national-level economic inequality) using the following formula:

$$T_{total} = T_{inter} + \sum_{i} P_i \; x \; T_{intra}$$

   Variable Explanation:
   T_{Total} = National Theil Index
   T_{Inter} = Theil Index between islands
   T_{Intra} = Theil Index within islands
   P_i = Proportion of each island's GDP compared to the national GDP

Criteria for Results Testing:

1. If the Theil Index value is larger, it indicates higher economic inequality and less equitable distribution.
2. If the Theil Index value is smaller, it indicates lower economic inequality and a more equitable distribution of income.

3.2.2. Analysis of Per Capita Income Inequality Among Major Islands in Indonesia Using the Theil Index

The Theil Index is chosen to measure the level of economic inequality due to its ability to analyze income distribution or GDP per capita in detail. This index also allows for the decomposition of inequality into *within-region* and *between-region* components.

1. Within-Region Inequality (Intra-Group): This measures inequality among provinces within each major island.

   Within-Island Theil Index Formula:

$$T_{Intra} = \sum_{i} \frac{n_p}{n_i} \; x \; ln\left(\frac{Y_p/n_p}{Y_i/n_i}\right)$$

   Variable Explanation:

   T_{Intra} = Theil Index within the island
   Y_p = Total income of the province within the island
   Y_i = Total income across all provinces within the island
   n_p = Total population of the province
   n_i = Total population of the island

   Total Within-Island Inequality:

   The total inequality across all major islands is the sum of within-island inequalities:

   Total Tintra = Tintra Sumatera + Tintra Java + Tintra Kalimantan+...

2. Between-Region Inequality (Inter-Group): This measures inequality across the six major islands.

   Between-Island Theil Index Formula:

$$T_{Inter} = \sum_{p=1}^{P} \frac{Y_i}{Y_N} \; x \; ln \; \frac{Y_i/n_i}{Y_N/n_N}$$

   Variable Explanation:

   T_{Inter} = Theil Index between regions/islands
   Y_i = GDP of the group/region/major island
   Y_N = National total GDP
   n_i = Population of the island
   n_N = Total population of the nation

Calculating National Per Capita Inequality:

After computing T_{Intra} and T_{Inter}, the national-level per capita inequality can be calculated as follows:

$$T_{Total} = T_{Intra} + T_{Inter}$$

Theil Index Interpretation Criteria:

Table 1. Theil Index Interpretation Categories

Theil Index (T)	Inequality Category	Interpretation
$0 \leq T < 0,1$	Very Low Inequality	Inequality is almost non-existent; income distribution or contribution is very even.
$0,1 \leq T < 0,3$	Low Inequality	Although differences exist, the distribution remains relatively even.
$0,3 \leq T < 0,5$	Moderate Inequality	Indicates some inequality but not too extreme.
$0,5 \leq T < 0,7$	High Inequality	Inequality is significant, indicating a trend toward concentration in certain groups.
$T \geq 0,7$	Very High Inequality	Inequality is very pronounced; economic contributions or income are heavily concentrated among a few groups.

4. Results and Discussion

4.1. Research Results

4.1.1. Economic Contribution Inequality Among Major Islands in Indonesia

Table 2. Results of Theil Index Calculation for Inter-Province Inequality in Economic Contribution

Island	T_{Intra} Island	Proportion	Contribution
Sumatera	2,0701	0,2093	0,4333
Java	1,5406	0,5863	0,9033
Bali-Nusa Tenggara	0,4020	0,0272	0,0109
Kalimantan	0,8912	0,0824	0,0735
Sulawesi	0,8440	0,0681	0,0575
Maluku - Papua	0,5039	0,0266	0,0134
T_{Intra} Total (in economic contribution)			**1,4919**

Category Values	Value
T_{Intra}	1,4919
T_{Inter}	1,2237
$T_{Total} = T_{Intra} + T_{Inter}$	**2,2716**

Source: Processed data from Excel, 2024

The calculation of Theil Index indicates the variation of inter-province inequality in economic contributions across each major island in Indonesia. Based on Table 2, the following observations can be made: 1) Within-Island Inequality (T_{Intra}): Java has the highest T_{Intra} value of 1.5406, reflecting significant economic inequality among its provinces. This can be attributed to the dominance of DKI Jakarta and West Java in the national GDP. 2) Bali and

Nusa Tenggara, these regions have the lowest T_{Intra} value of 0.4020, indicating a relatively even distribution of economic contributions among their provinces. 3) Proportion of GDP and Contribution, Java contributes the largest proportion of national GDP (58.63%) and has the dominant economic contribution (0.9033) to inequality. Other islands like Bali and Maluku-Papua contribute relatively less to inequality due to their lower GDP proportions. 4) Total Inequality (T_{Total}), The total inequality is 2.2716, comprising T_{Intra} (1.4919) and T_{Inter} (1.2237). This demonstrates that intra-island inequality is more dominant than inter-island inequality.

4.1.2. Per Capita Income Inequality Among Major Islands in Indonesia

Table 3. Results of Theil Index Calculation for Inter-Province Inequality in Per Capita Income

Island	T_{intra} Island	Contribution to T_{Intra} (%)
Sumatera	0,0801	0,0955
Java	0,2189	0,2611
Bali-Nusa Tenggara	0,0837	0,0998
Kalimantan	0,2399	0,2861
Sulawesi	0,0300	0,0358
Maluku - Papua	0,1858	0,2216
T_{Intra} Total (in per capita income)	0,8384	
Category Values	**Value**	
T_{Intra}	0,8384	
T_{Inter}	0,0136	
$T_{Total} = T_{Intra} + T_{Total}$	**0,8520**	

Source: Processed data from Excel, 2024

The analysis using Theil Index reveals the following about per capita income inequality among provinces in Indonesia. 1) Total Income Inequality: The total calculated value is 0.8520, which includes T_{Intra} (intra-island inequality): 0.8384 and T_{Inter} (inter-island inequality): 0.0136. 2) Dominance of Intra-Island Inequality: The Tintra component is dominant, accounting for almost 98.4% of the total inequality. This shows that most of the inequality in per capita income occurs within islands rather than across islands. 3) Kalimantan's Contribution: Kalimantan has the highest T_{Intra} value (0.2399) with the greatest contribution (28.61%) among all islands, indicating significant income disparities within the island despite its wealth of natural resources. 4) Comparison with Sulawesi: Sulawesi shows much lower T_{Intra} (0.0300) with minimal contribution (3.58%), reflecting a more equitable distribution of income within the island.

4.2. Discussion

4.2.1. Inequality in Economic Contribution

The results of this study indicate that economic contribution inequality among provinces in Indonesia, measured using the Theil index, has a total value of 2.2716. This inequality consists of T_{intra} (intra-island inequality) of 1.4919 and T_{Inter} (inter-island inequality) of 1.2237. These findings highlight that intra-island inequality remains the dominant component of the total economic inequality, with the highest T_{Intra} value observed in Sumatra (2.0701) and the lowest in Bali and the Nusa Tenggara Islands (0.4020). The high T_{Intra} value in Sumatra

indicates significant disparities between resource-rich provinces such as Riau and provinces with minimal economic contribution like Bengkulu.

According to Kim (2008) theory of regional inequality, economic inequality is more pronounced in the early stages of development due to the concentration of economic activity in certain regions with comparative advantages. These findings align with the economic contribution of Java Island, which accounts for 58% of the national GDP, underscoring the pattern of central economic dominance in the national economic system. However, the significant presence of T_{Inter} suggests that disparities in inter-island economic structures, including unequal access to infrastructure and investment, remain significant challenges.

These findings are consistent with Aritenang (2014) observations, which noted that regional inequality in Indonesia is more influenced by intra-regional factors. Conversely, Kuncoro (2013) showed that regional autonomy has not yet fully reduced inter-regional inequalities in Indonesia. The high T_{Intra} values in Sumatra and Java reflect provincial heterogeneity within these islands, while the relatively low T_{Intra} values in Bali and Nusa Tenggara indicate economic homogeneity among their respective provinces.

In developing countries, economic inequality also remains a major issue. For example, Guo et al. (2020) found in China that regional inequality tends to increase with urbanization and industrialization, particularly concentrated in the eastern regions. Similarly, Azzoni & Haddad (2018) identified that regional inequality in Brazil was influenced by disparities in infrastructure investment and income distribution. This study's findings are in line with patterns observed in other developing countries, where central regions tend to dominate economically, while peripheral areas lag behind.

To address these inequalities, policies focusing on the development of underdeveloped areas, improved infrastructure, and more equitable distribution of investment are crucial. Programs such as the acceleration of development in Eastern Indonesia (KTI) could provide solutions to reduce inter-island disparities. Additionally, economic decentralization policies may help mitigate intra-island inequality.

4.2.2. Inequality in Economic Contribution

The study reveals that the per capita income disparity among provinces in Indonesia results in a total Theil Index value of 0.8520, with T_{Intra} (intra-island inequality) contributing 0.8384 and T_{Inter} (inter-island inequality) contributing 0.0136. The dominance of T_{Intra} over T_{Inter} highlights that income inequality primarily occurs within islands rather than between them, as evidenced by $T_{Intra's}$ contribution of nearly 98.4% to the total disparity.

Kalimantan exhibits the highest T_{Intra} value (0.2399), accounting for 28.61% of the total T_{Intra}. This indicates significant income distribution disparities within Kalimantan, despite its wealth of natural resources such as mining and forestry. Conversely, Sulawesi demonstrates a relatively low T_{Intra} value (0.0300) with a contribution of only 3.58%, indicating a more equitable income distribution across the island.

Theoretically, these findings align with Arthur Lewis's Dual Economy Model, which explains disparities as stemming from differences in development levels between economically advanced regions and less developed areas. The high intra-island disparities in Kalimantan and Java, for instance, can be attributed to the concentration of productive sectors in urban areas compared to rural regions.

These results are consistent with Aritenang (2014) reported comparable findings, where regional disparities were largely influenced by differences in urban and rural development levels within the same island. Other developing countries, such as China, have shown similar patterns. Song (2013) found that disparities are primarily driven by income distribution differences within provinces rather than between provinces.

These findings underline the importance of policies focused on reducing intra-island inequality, such as increasing infrastructure investment in remote areas and developing inclusive economic sectors. Additionally, redistributive policies targeting education and healthcare access can play a crucial role in mitigating disparities within regions characterized by uneven development levels.

5. Conclusion

This study has revealed two main findings from the analysis of the Theil Index related to economic and income inequality among provinces in Indonesia. Based on the first analysis, the total value of the Theil Index for inter-provincial economic contribution is 2.2716, with T_{Intra} (intra-island inequality) accounting for 1.4919 and T_{Inter} (inter-island inequality) accounting for 1.2237. This indicates that economic inequality among provinces in Indonesia is influenced more by intra-island disparities than inter-island differences. The province of Sumatra shows the highest T_{Intra} value (2.0701), indicating significant disparities among provinces in economic activity and resource contribution within the island.

Meanwhile, the results of the second analysis show that the total Theil Index value for per capita income inequality is 0.8520, with T_{Intra} contributing 0.8384 and T_{Inter} contributing 0.0136. The dominance of T_{Intra} in per capita income inequality indicates that disparities are more pronounced within islands than between islands. Kalimantan has the highest T_{Intra} value (0.2399) with a contribution of 28.61%, indicating highly uneven income distribution within the island. Conversely, Sulawesi has a relatively low T_{Intra} value (0.0300) with a contribution of only 3.58%, indicating a more equitable income distribution.

Based on the findings of this study, several policy recommendations and research suggestions can be formulated to address economic and income inequality among provinces in Indonesia:

1. Policies focusing on infrastructure development and equitable distribution in remote areas should be prioritized to reduce intra-island inequality.
2. The acceleration of development programs in Eastern Indonesia (KTI) should continue to reduce inter-island disparities.
3. Future research should conduct an in-depth study of the factors contributing to intra-island inequality and identify effective strategies to reduce these disparities.

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