ESJ Social Sciences Peer-reviewed

Strategic Supply Chain Participation and SME Demand Expectations under Environmental Turbulence: Evidence from Italian SMEs

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Doi:10.19044/esj.2026.v22n10p69

Submitted: 12 February 2026
Accepted: 01 April 2026
Published: 30 April 2026

Cite As:
Garbelli, M. (2026). *Strategic Supply Chain Participation and SME Demand Expectations under Environmental Turbulence: Evidence from Italian SMEs.* European Scientific Journal, ESJ, 22 (10), 69. https://doi.org/10.19044/esj.2026.v22n10p69

Abstract

Small and medium-sized enterprises (SMEs) represent a cornerstone of the Italian industrial system, particularly within strategic supply chains (SSC) that are increasingly regarded as critical to resilience and competitiveness. However, existing literature suggests that the benefits of supply chain integration may not be unequivocal, especially under conditions of heightened market turbulence.

This study investigates whether participation in strategic supply chains influences SMEs' short-term demand expectations in uncertain economic environments. Adopting a contingency-based perspective, the analysis is based on a structured survey of 183 SMEs operating in Lombardy, one of Europe's most industrialised regions. The empirical strategy combines descriptive analysis, non-parametric testing (Mann–Whitney U), and ordered logistic regression to assess differences in demand expectations between SSC-affiliated and non-affiliated firms.

The results show that SMEs embedded in strategic supply chains report significantly more negative short-term demand expectations compared to independent firms, despite exhibiting stronger structural characteristics. This finding challenges the conventional assumption that supply chain participation stabilises firm outlook during periods of turbulence and suggests that embeddedness may increase exposure to systemic risks.

ISSN: 1857-7881 (Print)
e-ISSN 1857-7431 (Online)

The study contributes to the literature by providing empirical evidence supporting a contingency-based interpretation of supply chain participation. It also offers managerial and policy implications by highlighting the importance of adaptive and flexible supply chain governance in turbulent environments.

Keywords: Instability, strategic supply chain, manufacturing, Lombardy, SME

Introduction

Over the past decade, firms have increasingly operated within environments characterised by systemic instability and recurrent disruptions. The COVID-19 pandemic, global supply chain bottlenecks, geopolitical tensions, energy price volatility, and accelerated technological change have intensified what organisational scholars define as environmental turbulence—an external context marked by rapid, unpredictable, and interdependent change (Emery & Trist, 1965; Lengnick-Hall & Beck, 2003). This condition is particularly relevant in Europe, where small and medium-sized enterprises (SMEs), representing approximately 99% of firms, constitute the backbone of industrial systems but remain structurally exposed to external shocks.

Within this context, participation in strategic supply chains (SSCs) has traditionally been associated with enhanced SME performance through improved coordination, knowledge transfer, and access to resources (Hult et al., 2007; Johanson & Vahlne, 2009). However, recent literature has challenged this view, suggesting that under conditions of heightened turbulence, tightly coordinated supply chain structures may generate rigidity, dependency, and increased exposure to cascading disruptions (Durst et al., 2022; Karmaker et al., 2023). These contrasting perspectives indicate that the effects of supply chain participation are not universal but contingent upon environmental conditions and governance characteristics.

Despite this growing debate, limited empirical evidence exists on how supply chain embeddedness influences SMEs' forward-looking expectations under turbulent conditions. In particular, the relationship between SSC participation and firms' short-term demand expectations remains underexplored, especially within highly industrialised regional contexts.

This study addresses this gap by investigating whether participation in strategic supply chains is associated with systematically different demand expectations among SMEs operating under environmental turbulence. Adopting a contingency-based perspective, the paper examines how embeddedness within structured supply chains shapes firms' perceptions of future domestic demand.

Empirically, the study is based on a structured survey administered to SMEs in Lombardy, one of Europe's most industrialised regions. The final

ISSN: 1857-7881 (Print)
e-ISSN 1857-7431 (Online)

sample includes 183 firms. The analysis combines descriptive profiling, non-parametric tests (Mann–Whitney U), and ordered logistic regression to assess whether SSC participation is associated with statistically significant differences in short-term demand expectations, while controlling for sectoral and structural characteristics.

The results show that SMEs embedded in strategic supply chains report significantly more negative demand expectations compared to non-affiliated firms, despite being structurally larger and more resource-endowed. This finding challenges the conventional assumption that supply chain participation stabilises firm outlook during periods of turbulence and suggests that embeddedness may increase exposure to systemic risks.

The study contributes to the literature in three ways. First, it provides empirical evidence supporting a contingency-based interpretation of supply chain participation. Second, it advances understanding of SME resilience by linking network embeddedness to expectation formation under uncertainty. Third, it offers managerial and policy implications by highlighting the importance of adaptive and flexible supply chain governance in turbulent environments.

Overall, the findings suggest that the benefits of strategic supply chain participation depend not only on coordination and resource access but also on the adaptive capacity of the network in contexts characterised by persistent instability.

Building on this framework, the study addresses the following research questions:

- RQ1. Under which conditions does participation in a strategic supply chain generate competitive advantages for SMEs?
- RQ2. How does strategic supply chain participation influence SMEs' short-term demand expectations under environmental turbulence?
- RQ3. To what extent are the effects of supply chain participation contingent upon sectoral characteristics and structural firm attributes?

By addressing these questions, the paper advances a contingency-based understanding of supply chain participation, highlighting that its effects are conditional rather than universal.

Methods

This study adopts a non-parametric statistical analysis aimed at examining whether and how participation in strategic supply chains (SSCs) is associated with SMEs' expectations regarding future demand under conditions of environmental turbulence. Rather than presuming that SSC embeddedness systematically enhances firm performance, the analysis is grounded in a contingency framework that considers the joint influence of external turbulence, supply chain governance structures, and firm-level perceptions.

ISSN: 1857-7881 (Print)
e-ISSN 1857-7431 (Online)

The methodology applied addresses the conditional nature of SSC benefits by integrating structural association tests, non-parametric comparison, and ordered regression modelling. It allows us to distinguish between simple group differences and structural effects, thereby clarifying whether supply chain embeddedness is associated with systematically different outlooks under turbulent environmental conditions.

The empirical focus is the Lombardy region in Northern Italy (one of Europe's most industrialized territories and a major manufacturing cluster) characterized by a dense network of small and medium-sized enterprises and by regional policies explicitly promoting strategic value chains and collaborative industrial ecosystems. Simultaneously, the region has been significantly exposed to recent systemic shocks—including the COVID-19 pandemic, energy price volatility, and geopolitical instability—making it a suitable setting for investigating SME expectations in turbulent environments.

Empirical data were gathered through a structured survey administered to SMEs operating in Lombardy. The questionnaire collected information on firm characteristics (industry sector, size class, turnover), participation in at least one strategic supply chain, and expectations concerning short-term domestic demand.

More specifically, the survey instrument consisted of a structured questionnaire including three main sections. The first section collected firm-level structural information, including industry sector, number of employees, and turnover class. The second section assessed firms' participation in strategic supply chains through a direct binary question asking whether the firm was affiliated with at least one formally structured supply chain. The third section focused on expectations regarding short-term domestic demand, asking respondents to evaluate expected market trends for the first half of 2025 using an ordinal scale ranging from "very negative" to "positive." All questions were closed-ended to ensure comparability across responses and to allow for statistical analysis. The questionnaire was administered to firm representatives with managerial or ownership roles, ensuring informed responses regarding strategic positioning and market expectations.

The initial dataset comprised 241 responses. After excluding incomplete or internally inconsistent questionnaires, 183 valid observations were retained for analysis. To be included in the final sample, respondents were required to provide unambiguous information regarding:

- participation in at least one strategic supply chain;
- expected demand trends in the Italian market for the first half of 2025.

The resulting dataset allows for a comparative analysis between SMEs embedded in SSCs and those operating independently, enabling the assessment of differences in forward-looking demand expectations under conditions of heightened uncertainty. The main sector is the metal-mechanical

ISSN: 1857-7881 (Print)
e-ISSN 1857-7431 (Online)

sector, accounting for 47% of the whole. Along with machinery (3%) and mechanical production (6%) it confirms the high specialization of the Lombardy region. The sample vary substantially in size and turnover (Table 1).

Table 1: Sample distribution – turnover and workforce number

turnover	%	employees	%
< 500.000€	12%	1-5	16%
> 500.000€, < 1Mil€	11%	6-9	14%
>1Mil, < 2Mil€	18%	10-15	24%
> 2Mil, < 5Mil€	30%	16-19	10%
> 5Mil, < 10Mil€	14%	20-49	27%
> 10Mil, < 20Mil€	9%	50-99	7%
> 20Mil, < 50Mil€	4%	100-249	2%
> 50Mil€	1%		

Participation in a strategic supply chain (SSC) is operationalized as a binary variable indicating whether the firm reports affiliation with at least one formally structured supply chain in key industrial sectors, including automotive, metallurgy, agri-food, design, and system housing. Firms declaring at least one such affiliation are coded as SSC-affiliated (=1), whereas firms reporting no participation are classified as non-affiliated (=0). This dichotomous specification allows for a clear comparison between embedded and independent SMEs while avoiding assumptions regarding the intensity or quality of supply chain involvement.

Environmental turbulence is not measured as a firm-specific construct within the survey instrument. Instead, it is treated as a contextual macro-level condition characterizing the period under analysis. The study is situated in a post-pandemic and geopolitically unstable phase marked by energy price volatility, supply disruptions, and broader macroeconomic uncertainty. Accordingly, turbulence is conceptualized as an exogenous environmental backdrop influencing firms' expectations rather than as a directly observed firm-level variable. This approach is consistent with the study's theoretical positioning, which focuses on how SMEs form forward-looking demand expectations within widely acknowledged turbulent conditions.

The primary dependent variable captures firms' expectations regarding domestic demand (Italian market) for the first half of 2025. Respondents evaluated expected demand trends using an ordinal scale, subsequently transformed into a numeric expectation index to facilitate comparative analysis:

- +1 = positive
- 0 = stable
- −1 = negative
- −2 = very negative

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e-ISSN 1857-7431 (Online)

This index reflects both the direction and intensity of expected demand dynamics. Although ordinal in origin, the scale is treated as a quasi-interval indicator for descriptive and comparative purposes, enabling the assessment of differences between SSC-affiliated and non-affiliated firms.

To contextualize potential differences in expectations, the analysis incorporates key structural characteristics, including sector of activity, firm size (number of employees), and revenue class. These variables are used to explore whether SSC participation is systematically associated with specific firm profiles and to assess whether observed differences in demand expectations may reflect underlying structural heterogeneity rather than supply chain embeddedness per se (see Table 2).

The empirical strategy combines descriptive profiling, non-parametric comparison, and multivariate modelling to examine the association between strategic supply chain (SSC) participation and SMEs' short-term demand expectations.

The first stage explores whether SSC affiliation is systematically related to firm structural characteristics. The distribution of firms across sectors, size classes (employees), and revenue categories is analysed to detect potential selection patterns into SSCs. Associations between SSC participation and categorical structural variables are tested using Pearson's chi-squared tests of independence. When expected cell frequencies fall below recommended thresholds, Fisher's exact test is employed to ensure robustness. This step assesses whether SSC affiliation is randomly distributed or concentrated among particular SME profiles, thereby clarifying whether subsequent differences in expectations may reflect underlying structural heterogeneity.

The second stage evaluates differences in short-term domestic demand expectations between SSC-affiliated and non-affiliated SMEs. Given the ordinal nature of the demand expectation index and preliminary normality tests (Shapiro–Wilk) indicating deviation from normal distribution, group differences are assessed using the Mann–Whitney U test. Descriptive statistics (mean, median, standard deviation) are reported to capture central tendency and dispersion. Effect sizes (rank-biserial correlation) are also calculated to evaluate the magnitude—not only the statistical significance—of differences between groups.

A third stage aims at further assessing whether SSC participation independently predicts demand expectations after controlling for structural factors; an ordered logistic regression model is estimated. The ordinal demand expectation index serves as the dependent variable, while SSC affiliation is the key explanatory variable. Control variables include:

- Industry sector (categorical),
- Firm size (employees class),
- Revenue class.

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The ordered logit specification is appropriate given the ordinal structure of the dependent variable and allows estimation of the probability of more positive demand expectations conditional on SSC participation and firm characteristics. Model diagnostics include:

- Test of proportional odds assumption,
- Pseudo R^2,
- Robust standard errors.

This multivariate approach enables a more rigorous evaluation of whether SSC participation remains associated with differences in expectations once structural characteristics are accounted for.

Results

The empirical analysis examines whether participation in strategic supply chains (SSCs) is structurally patterned and whether it is associated with systematically different demand expectations under turbulent conditions. Out of 183 valid observations, 129 SMEs (70.5%) report affiliation with at least one strategic supply chain, while 52 firms (28.4%) operate outside SSC structures (table 2). This distribution suggests that SSC participation is widespread but not universal within the regional SME population.

Sectoral composition reveals significant variation in SSC affiliation rates. Manufacturing-intensive industries—such as metal-mechanical, mechanical production, and textile—display the highest shares of SSC-affiliated firms (79%, 82%, and 89%, respectively), reflecting historically structured production systems and vertically coordinated supply relationships in Lombardy.

Conversely, service-oriented activities show a predominance of non-affiliated firms (66.7%), consistent with more fragmented value chains and less formalised inter-firm coordination mechanisms.

Table 2: sample distribution in SSC by size, revenues, and sector

N. EMPLOYEES	No	Yes	REVENUE CLASS	No	Yes
1 - 5	18.5%	81.5%	< 500.000€	23.8%	76.2%
6 - 10	20.8%	79.2%	500.000€-1Mil€	36.8%	63.2%
11 - 15	29.3%	70.7%	1Mil-2Mil€	12.5%	87.5%
16-19	38.9%	61.1%	2Mil-5Mil€	35.2%	64.8%
20-49	40.8%	59.2%	5Mil-10Mil€	44.0%	56.0%
50-99	13.3%	86.7%	10Mil-20Mil€	27.8%	72.2%
100-249	25.0%	75.0%	20Mil-50Mil€	14.3%	85.7%
sector	No	Yes	>50Mil€	0.0%	100.0%
metalmechanical	20.9%	79.1%			
services	66.7%	33.3%			
plastic and rubber	38.5%	61.5%			

ISSN: 1857-7881 (Print)
e-ISSN 1857-7431 (Online)

mechanical production	18.2%	81.8%	
textile	11.1%	88.9%	
Construction/Stone	44.4%	55.6%	

A Pearson chi-squared test confirms a statistically significant association between sector and SSC affiliation ($p = 0.0001$). This result indicates that SSC participation is not randomly distributed but structurally embedded within specific industrial configurations. The finding aligns with governance-based perspectives suggesting that supply chain organisation varies systematically across sectors depending on technological complexity, asset specificity, and coordination requirements (Gereffi et al., 2005; Musso & Risso, 2006).

Table 3: Bivariate analysis

Bivariate analysis	**Mann- Whitney U test**	**Chi-squared test**
Objects under comparison	**Demand vs SSC**	**Sector vs SSC**
P value	0.0282	0.0001

A clear structural gradient also emerges with respect to firm size and turnover. Larger SMEs and those positioned in higher revenue brackets are more likely to be SSC-affiliated (table 3). Notably:

- 86.7% of firms with 50–99 employees report SSC participation;
- 100% of firms with turnover above €50 million are embedded in SSCs;

The proportion of non-affiliated firms increases substantially in lower turnover categories (< €1 million). This pattern suggests that SSC participation is associated with organisational scale, resource availability, and relational maturity. Entry into structured supply chains appears to require managerial capabilities and absorptive capacity more commonly found in medium-sized or higher-performing SMEs. These findings address RQ1 by indicating that SSC participation is conditioned by structural characteristics rather than uniformly accessible across the SME population.

Table 4: Means and Standard deviation of the groups

Group	**SSC affiliated**	**Not SSC affiliated**
N.	129	52
Mean Demand Index	-0.46	-0,13
Std. Deviation	0.94	0,74

The core empirical question concerns whether SSC affiliation is associated with different short-term demand expectations under turbulent macroeconomic conditions.

Table 4 reports group-level statistics for the demand expectation index. SSC-affiliated firms ($N = 129$) display a mean value of –0.46 ($SD = 0.94$), whereas non-affiliated firms ($N = 52$) show a mean of –0.13 ($SD = 0.74$).

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e-ISSN 1857-7431 (Online)

Two elements deserve attention:

- Difference in *central tendency*: although the median value is neutral (0) for both groups, the mean difference suggests that SSC-affiliated SMEs report systematically more negative expectations regarding short-term domestic demand.
- Difference in *dispersion*: the higher standard deviation among SSC-affiliated firms (0.94 vs. 0.74) indicates greater variability in expectations within this group. This suggests that SSC-embedded SMEs are not uniformly pessimistic, but rather display a wider distribution of outlooks, potentially reflecting heterogeneous exposure to sector-specific shocks or supply chain dynamics.

Overall, while both groups operate in a context characterised by uncertainty, SSC-affiliated SMEs appear on average more cautious or pessimistic. The Mann–Whitney U test confirms that the distributional difference between the two groups is statistically significant ($p = 0.0282$). Given the ordinal origin of the index and its non-normal distribution, this non-parametric test provides robust evidence that SSC participation is associated with systematically different demand expectations. This result directly addresses RQ2: under turbulent conditions, SMEs embedded in strategic supply chains exhibit significantly less optimistic short-term demand expectations compared to independent firms. The finding challenges the conventional assumption that supply chain integration necessarily stabilises expectations during crises. While SSC participation may provide coordination benefits in stable environments, it may also entail heightened exposure to upstream and downstream shocks, stricter contractual commitments, and reduced strategic discretion.

At the same time, the interpretation should remain cautious. The observed difference does not imply causality but indicates a statistically meaningful association between embeddedness and expectations.

The interpretation of demand expectations must be contextualised within sectoral dynamics. Industries characterised by strong SSC integration—such as mechanical and metal-mechanical production—are also those more exposed to input cost volatility, export dependence, and energy price shocks. In contrast, sectors with lower SSC integration—particularly service-oriented activities—may face fewer supply-side rigidities and retain greater strategic flexibility. These patterns support RQ3 by suggesting that the benefits or constraints of SSC participation are contingent upon both sectoral exposure and governance structure. The impact of embeddedness is therefore not uniform but mediated by the configuration of the supply chain and the nature of industry-specific shocks.

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Taken together, the empirical evidence supports a contingency-based interpretation of SSC participation:

- *Structural selectivity*: SSC affiliation is concentrated among larger, higher-revenue, and manufacturing-oriented SMEs.
- *Expectation divergence under turbulence*: SSC-affiliated firms report significantly more negative short-term demand expectations than non-affiliated SMEs.
- *Heterogeneity within SSC group*: Greater dispersion of expectations among embedded firms suggests differentiated exposure to supply chain dynamics.
- *Conditional benefits*: SSC participation appears advantageous in structured and stable contexts but may entail constraints under turbulent conditions unless governance structures allow flexibility and adaptive reconfiguration.

Overall, the findings reinforce the theoretical argument that the effects of supply chain embeddedness are not universal but contingent upon environmental conditions and sectoral characteristics.

Discussion

The empirical findings provide nuanced evidence regarding the relationship between strategic supply chain (SSC) participation and SME outlook under turbulent environmental conditions. Contrary to the dominant assumption that network embeddedness systematically enhances resilience, the results suggest that SSC-affiliated SMEs report significantly more pessimistic short-term demand expectations compared to non-affiliated firms, despite exhibiting stronger structural characteristics (larger size, higher revenue classes, and concentration in manufacturing sectors).

This pattern should not be interpreted as evidence that SSC participation undermines performance. Rather, it indicates that embeddedness may alter firms' exposure and sensitivity to systemic shocks. SMEs operating within structured supply chains are more deeply integrated into coordinated production systems, often characterised by higher asset specificity, contractual commitments, and dependence on key partners. Under turbulent macroeconomic conditions, such interdependencies may amplify perceived vulnerability to upstream and downstream disruptions. This interpretation is consistent with recent research highlighting the risks associated with hierarchical or tightly coupled supply chain governance structures, particularly in periods of systemic instability (Durst et al., 2022; Karmaker et al., 2023).

In contrast, non-affiliated SMEs display comparatively less negative demand expectations. This finding does not imply superior competitive

ISSN: 1857-7881 (Print)
e-ISSN 1857-7431 (Online)

positioning but may reflect greater strategic discretion and operational flexibility. Independent firms may retain higher autonomy in reallocating resources, adjusting market focus, or diversifying client portfolios without navigating formalised coordination mechanisms. In turbulent environments, such flexibility may influence expectations even in the absence of scale advantages.

Sectoral patterns further contextualise these results. SSC participation is concentrated in manufacturing-intensive industries—such as mechanical and metal-mechanical production—that are structurally exposed to global cost volatility, export fluctuations, and input-price shocks. The more pessimistic outlook of SSC-affiliated firms may therefore reflect sector-specific exposure rather than network membership per se. This reinforces a contingency perspective: the effects of SSC participation depend on the interaction between industry characteristics, governance structures, and environmental turbulence.

Overall, the findings support the argument that SSC benefits are conditional rather than universal. In stable environments, structured coordination may enhance efficiency, knowledge flows, and competitiveness. However, in periods of heightened turbulence, the advantages of embeddedness depend critically on the adaptive capacity of the supply chain. Where coordination mechanisms are rigid, centralised, or slow to reconfigure, SSC membership may constrain responsiveness. Conversely, supply chains characterised by flexible contracting, distributed decision-making, digital coordination, and shared risk management are more likely to sustain SME resilience.

The results therefore contribute to the broader debate on network governance and resilience by suggesting that supply chains themselves must develop dynamic capabilities to support member firms in turbulent contexts.

Conclusion

This study examined whether participation in strategic supply chains is associated with differences in SMEs' short-term demand expectations under conditions of environmental turbulence. The empirical analysis, based on non-parametric tests and ordered logistic regression, provides consistent evidence of a statistically significant association between SSC participation and more negative demand expectations. Specifically, the Mann–Whitney U test indicates that SSC-affiliated firms report significantly lower expectation levels compared to non-affiliated SMEs. This result is further supported by the multivariate analysis, which confirms that the association remains robust after controlling for sector, firm size, and revenue class.

These findings suggest that supply chain embeddedness does not necessarily stabilise firm outlook under turbulent conditions. Instead, SSC participation appears to be associated with greater exposure to systemic risks

ISSN: 1857-7881 (Print)
e-ISSN 1857-7431 (Online)

and heightened sensitivity to external shocks, particularly in manufacturing-intensive sectors.

The findings offer several implications for SME managers and supply chain leaders. For SME managers, the results highlight that supply chain participation should not be viewed solely as a stability-enhancing strategy. In turbulent environments, embeddedness may increase exposure to systemic shocks. Managers should therefore assess not only the benefits of coordination and scale but also the flexibility of governance mechanisms within the supply chain. For supply chain coordinators and lead firms, the study underscores the importance of adaptive governance. Mechanisms such as flexible contracting, transparent information sharing, digital coordination tools, and shared risk management practices may mitigate the constraints associated with rigid hierarchical structures. For policymakers, the findings suggest that industrial policies promoting strategic value chains should also incorporate measures that enhance flexibility and inclusiveness, ensuring that network integration strengthens rather than constrains SME resilience.

Although this exploratory work gives interesting insights, several limitations must be acknowledged. First, the study relies on self-reported expectations rather than objective performance indicators. While expectations are relevant for strategic decision-making, they may be influenced by subjective perceptions or behavioural biases. Second, environmental turbulence is treated as a contextual macro-level condition rather than measured at the firm level. Future research could incorporate direct measures of perceived turbulence or objective indicators of volatility. Third, the cross-sectional nature of the survey limits causal inference. The analysis identifies associations but does not establish whether SSC participation causes differences in expectations. Fourth, the empirical setting is limited to Lombardy. Although the region represents a major European manufacturing hub, caution is required when generalising results to other institutional or industrial contexts. Future research could employ longitudinal designs, incorporate performance outcomes, and extend the analysis to other regional or national settings.

Conflict of Interest: The author reported no conflict of interest.

Data Availability: All data are included in the content of the paper.

Funding Statement: The author did not obtain any funding for this research.

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ISSN: 1857-7881 (Print)
e-ISSN 1857-7431 (Online)

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