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DETERMINANTS OF BUDGETED INFORMATION TECHNOLOGY EXPENDITURES

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Abstract

Information technology expenditures vary across firms and across industries; however, very little empirical research has investigated the factors influencing the level of these expenditures. The object of this paper is to present theory and evidence of the determinants of corporate IT budgets. Using InformationWeek data, we find that budgeted IT expenditures are significantly influenced by the strategic role that IT plays in an industry, and by the level of complexity arising from industry and firm-level factors. The level of concentration within the industry has a significant impact on IT budgets. A number of firm-level factors also affect IT budgets, including prior IT investments, resource availability, business volatility, and the level of diversification. This suggests that managers should adjust for these firm and industry-level factors when comparing their IT spending to selected benchmark firms.

1 INTRODUCTION

Over the last few decades, information technology (IT) has been one of the primary mechanisms managers have adopted to cope with increasing globalization, competition, and product market volatility. The scope and extent the use of IT is evident from the relentless rise in investment in computers and software in the US economy, which went from 5 percent of non-residential fixed investment in 1977 to 23 percent in 2000, totaling \$292 billion, nearly equaling investment in structures and exceeding all other categories (Bureau of Economic Analysis 2001).

Despite this rapid rise in IT spending, there has been limited investigation of the nature of IT investments being made beyond distinguishing between hardware and software (e.g. Gurbaxani et al. 2000), and even less of the firm and industry factors that affect IT investment levels. The observation by Orlikowski and Iacono (2001) that “IS research has not seriously engaged its core subject matter: the IT artifact...IT artifacts are not universal...[but] are embedded...[in] conditions [that] cannot be ignored, abstracted or assumed away” is particularly apt. They call for explicit theorizing about ITs with distinctive computational capabilities, used in various contexts.

With respect to the impact of contextual effects on IT budgets, Dewan et al. (1998) observe,

Previous researchers have analyzed the coordination requirements of alternative organizational structures and examined the implications for the use and impact of IT...[however] the analyses are largely theoretical in

nature. The [empirical] academic literature appears to have been more successful in explaining the time pattern of IT adoption and growth...than in elucidating firm characteristics that drive IT investments.

Motivated by this, Dewan et al. investigate the effects of a firm's scale and scope on IT investment, finding significant impacts. The purpose of this paper is to build on and expand their work by empirically investigating the impact of several firm and environmental factors on IT investment.

We investigate the impact of these factors on annual IT budgets, which quickly reflect managerial decisions in dynamic settings, rather than estimates of aggregate IT asset levels. The use of IT budget data complements analyses done with the IT capital data (Dewan et al. 1998), and has fewer measurement caveats, enabling the two approaches to be used to confirm or contradict each other. We begin by developing a research model and hypotheses and then test those hypotheses using annual IT budgets.

2 DEVELOPMENT OF RESEARCH MODE AND RESEARCH HYPOTHESES

Building on previous research in the information systems and organizational theory literatures, this paper adopts a contingency framework (see Figure 1) the central premise of which is that IT is an information processing mechanism that enables a firm's members to cope with external and internal complexity, and that we can better understand IT budget levels as a response to the sources of this complexity. Firms that operate in more competitive industries, are highly diversified, or have volatile levels of operational activity require a higher level of coordination to achieve desired performance targets (Galbraith 1977), leading to the necessity to acquire and apply more IT-enabled information processing functionalities and, hence, to higher IT budgets. Additionally, it is also recognized that a firm's earnings will affect the affordability of and incentives related to the acquisition of these IT-enabled information processing functionalities.

Further, the effects of these sources of complexity on IT budgets are not fixed but vary with the nature of the IT-enabled strategies used to address them. As will be developed later, IT can be used to automate, informate, or transform firms' business processes (Schein 1992) and, again as will be argued later, strategic IT role is expected to have both direct and indirect affects on firms' IT budgets. We do not propose that this model is exhaustive and, therefore, our empirical model also controls for other industry differences, as well as exogenous annual effects.

2.1 IT Effects: Industry IT Strategic Role

Different industries have different roles for information technology within their member organizations. One way of considering how IT is used within an industry is to determine what role IT plays in industry strategy. We consider industry strategic IT role as a potential determinant to explain the level of budgeted IT expenditures.

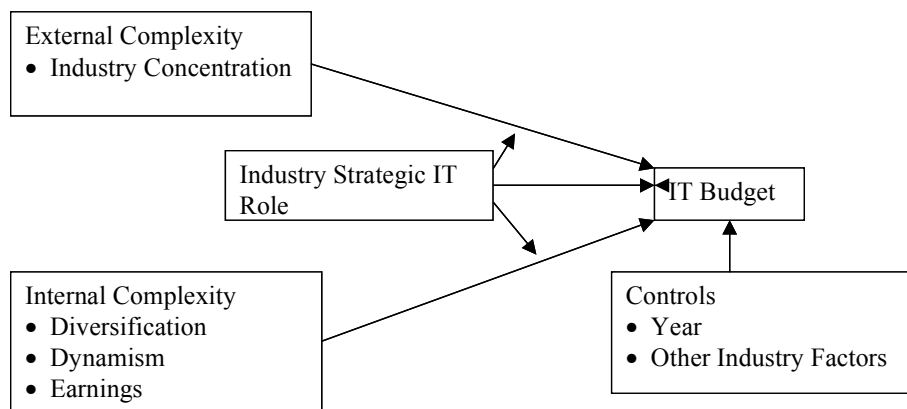


Figure 1. Research Model

Schein (1992) and Zuboff (1988) conceptualized four strategic roles for IT:

- automate, i.e., replace human labor by automating business processes
- informate up, i.e., provide information about business activities to senior management
- informate down, i.e., provide collective information about business activities to employees across the firm
- transform, i.e., apply IT in new ways to fundamentally redefine business processes and relationships

Armstrong and Sambamurthy (1999), and Chatterjee et al. (2001) have successfully applied this conceptualization in examining relationships associated with IT practices, business strategies, and firm performance.

Firms that use IT in a transformational role most often do so in order to position themselves more favorably within an industry, or develop a new industry niche by radically changing the industry's processes, practices, and business models. The intended market changes are disruptive rather than incremental, often requiring substantial organizational changes that increase the risk of failure; however, if successful, these projects promise higher returns (Venkatraman 1994). This probability of higher returns increases incentives for managers to invest in IT (Dewan and Mendelson 1998). Firms with membership in industries undergoing IT-driven transformation are likely to spend more on information technology than firms in other industries as they attempt to reposition themselves or develop a new industry niche.

Therefore, we hypothesize the following:

H1: The amount of budgeted IT expenditures is positively associated with a firm's membership in industries undergoing IT-driven transformation.

2.2 Affordability

IT expenditures are generally regarded as discretionary expenditures that are often set on the basis of what it is believed that the business can afford when other costs and financial constraints have been met. In this sense, IT expenditures are similar to other discretionary expenditures such as research and development (R&D), advertising expenditures, capital expenditures, maintenance, and training costs. Similar to research and development expenditures, external financing for IT may be expensive or difficult to obtain due to the inherent riskiness and uncertainty regarding the payoffs to IT expenditures. As a consequence, the level of internally generated funds may have as significant an influence on the timing and magnitude of IT expenditures as it does for R&D (Kamien and Schwartz 1978). Perry and Grinaker (1994) show that current-period free cash flows help predict the level of R&D investment. Likewise, empirical surveys report that practitioners frequently employ heuristics (e.g., percent of free cash flow) such as the affordability method in setting their advertising budgets (Tellis 1998). For example, Joseph and Richardson (2002) show that the annual change in earnings is positively correlated with the annual changes in advertising budgets.

We argue that the discretionary nature of the expenditures as well as the inherent riskiness and uncertainty regarding the payoffs to IT expenditures are similar to R&D and advertising expenditures and thus will be determined by the level of free cash flows (earnings) available to management.

Dewan and Mendelson (1998) present a complementary but distinct argument. They hypothesize that incentives for IT investment are a product of the profit potential of product markets and IT's ability to help realize that potential. If the earnings enjoyed by a firm are an indicator of its future profit potential and ability to harness IT to exploit that potential, firms with higher earnings are likely to be operating in settings that provide greater incentives toward IT investment.

The effect of earnings on IT spending has been a significant issue in empirical studies of IT's impacts on productivity (e.g., Brynjolfsson and Hitt 1995), where it is described as *reverse causality*, i.e., it is possible that IT investments are a result rather than a cause of increases in productivity and earnings. These studies assume it is significant, and rather than investigating and explaining its effect, they attempt to eliminate it by lagging IT investments in relation to changes in productivity and earnings.

We encapsulate these arguments in the following hypothesis:

H2: The amount of budgeted IT expenditures is positively associated with the level of firm earnings.

2.3 Diversification

Lawrence and Lorsch (1969) find that firms operating in a large number of product markets will have more specialized or *differentiated* functions. This higher level of specialization will in turn require a higher level of coordination or *integration*, to allow the components to achieve organizational goals. Within the IT productivity literature, Dewan et al. (1998) found diversification into multiple lines of business to be positively related to aggregate IT capital, providing empirical support for such a relationship within an IT setting. Accordingly, we hypothesize the following:

H3: The greater a firm's diversification, the greater the firm's budgeted IT expenditures.

2.4 Industry Concentration

Burns and Stalker (1961), Lawrence and Lorsch (1969), and Pfeffer and Salancik (1978) propose that environmental complexity is a function of the number of external actors that a firm must actively attend to in order to achieve marketplace success. Pfeffer and Salancik focus this logic on a firm's competitors, and find a positive relationship between industry concentration and environmental complexity. When between two to five competitors together effectively exercise control over a market, their individual behaviors can significantly impact each other. Further, when industry concentration is high (and, hence, only a few key rivals must be attended to), it becomes feasible to apply IT-enabled intelligence capabilities to gather information about these competitors in order to facilitate timely responses to their actions. As industry concentration decreases, perfect competition approaches, and no single firm can have a significant impact on the others. Thus, under perfect competition, there is no strategic gamesmanship, nor the sudden competitive adjustments associated with it, and less need for information systems that address these requirements.

A distinct but consistent incentive effect for IT spending is described by Dewan and Mendelson. Their theoretical study assumes strategic behavior is not possible, and finds that with increasing industry concentration, profits from IT investments are shared between fewer competitors, increasing the incentive for IT expenditures.

These arguments lead to the fourth hypothesis:

H4: The greater the industry concentration, the greater a firm's budgeted IT expenditures.

2.5 Dynamism

Another dimension of environmental complexity put forward by organizational theorists is dynamism, the rate of change in the environment. It is mirrored internally by changes in overall organizational activity levels and by continual changes in the tasks carried out by the firm or *task variability* (March and Simon 1958), a dimension of task complexity. Dewan and Mendelson derive that the value of an information system is proportional to the frequency of information events that it captures.

Several single industry studies in the IT productivity literature (Banker et al. 1990; Kelley 1994; Mukhopadhyay et al. 1995, 1997a, 1997b; Srinivisan et al. 1994) have found that task complexity moderates the performance effects of IT. Assuming firm and management incentives to improve performance, task complexity should, therefore, lead to variation in IT budgets.

Substantive changes in organizational activity levels and the way firms conduct their tasks are an important component of task complexity, and are reflected in changes in sales and expenses. Volatility in a firm's earnings is a reflection of environmental dynamism and related changes in a firm's tasks. Higher levels of dynamism and task complexity require higher levels of IT to cope with them.

H5: The amount of budgeted IT expenditures is positively associated with the volatility of earnings.

2.6 Interactive Effects

In addition to the direct effects hypothesized above and consistent with a contingent model, we expect that firm and environmental effects on IT spending are moderated by the strategic role of IT. More specifically, we expect firm and environmental effects to be higher in transformative industries.

The rationale for this is that managers' expected return from IT spending is the *joint* product of firm and environmental complexity that can be mitigated by IT, and IT's ability to mitigate those uncertainties. Managers of firms in complex settings will have less incentive to invest in IT if its ability to address that complexity is reduced. Similarly, managers in simple settings will benefit less from highly effective IT than managers in complex settings. Transformative industries are by definition those in which IT is being used in concert with organizational changes to substantially improve industry processes and relationships, reconstructing the relationship between context-driven complexity and IT and its impact on performance. Recent empirical research (Armstrong and Sambamurthy 1999; Chatterjee et al. 2001; Dehning et al. 2002) has found evidence that transformative IT investments are given higher value by investors. This leads to the following hypotheses:

H6: The relationship between budgeted IT expenditures and the level of firm earnings is more positive in transformative industries.

H7: The relationship between budgeted IT expenditures and the level of diversification is more positive in transformative industries

H8: The relationship between budgeted IT expenditures and industry concentration is more positive in transformative industries

H9: The relationship between budgeted IT expenditures and the volatility of earnings is more positive in transformative industries

3 MODEL

To test our hypotheses of the determinants of IT expenditures, we propose the following model:

$$IT_0 / Sales_{-1} = \alpha_0 + \alpha_1 IT_{-1} / Sales_{-1} + \alpha_2 Transform + \alpha_3 Earn_{-1} / Sales_{-1} + \alpha_4 Segments + \alpha_5 Ind Concentration + \alpha_6 SDEarn_{-1} / Sales_{-1} + \alpha_7 Size + \alpha_8 Transform * Earn_{-1} / Sales_{-1} + \alpha_9 Transform * Segments + \alpha_{10} Transform * Ind Concentration + \alpha_{11} Transform * SDEarn_{-1} / Sales_{-1} + \epsilon$$

where

IT_0	=	Budgeted IT Expenditures in year 0 (Source: <i>InformationWeek</i>)
Transform	=	1 if the budgeting firm is in an industry subject to a high level of IT-driven transformation; 0 otherwise (Source: Chatterjee et al. 2001)
$Earn_{-1}$	=	Earnings in year -1 (year prior to budget year) (Source: Compustat)
Segments	=	Number of reportable segments in each firm (Source: Compustat)
SDEarn	=	Standard deviation of annual earnings from years -4 to 0 (Source: Compustat)
Ind Concentration	=	Sales in year 0 of top four companies in four-digit SIC code divided by total sales of all companies in four-digit SIC code. (Source: Compustat)
Size	=	ln (market value of common equity) (Source: Compustat)

The testing of our model includes a version of the regression with and without lagged IT expenditures (IT_{-1}) to capture both the level of IT spending and the changes in IT expenditures from lagged IT expenditures. In our model, we also control for the possible effects of firm size. To control for industry differences in our pooled cross section analysis of firms, we perform our regression analysis using industry and annual dummies to help control for the mean differences across industries and years. For brevity, these dummy variables are not shown in the text, but are available upon request.

4 DATA

The source of IT expenditures budget data is *InformationWeek*. *InformationWeek* and *ComputerWorld* provide IT-related data such as IT budgets, number of IT employees, and other IT-related information as part of an annual published survey. This IT budget data from both public sources has been used extensively in other similar studies (see Brynjolfsson and Hitt 1996; Lichtenberg 1995). Lichtenberg provides evidence that there is a high correlation between the estimates of IT data from both of these public sources suggesting that either source would be reasonable. Since *InformationWeek* has IT budget data for a broader

set of firms than does *ComputerWorld*, it is used as our source of IT budget data over the 1992 to 1997 sample period. Starting in 1998, *InformationWeek* no longer includes IT budget data in their annual InformationWeek 500 issues. Our accounting and monthly and annual stock return data comes from *Compustat*.

5 RESULTS

Table 1 provides descriptive statistics regarding the sample. We note that in our sample, on average, firms spend 2.4 percent of their sales on IT expenditures. Table 2 provides Pearson correlation coefficients for the constructs examined in the study. Since many of the independent variables are highly correlated, variance inflation factors (VIF) were computed to assess multicollinearity in the regression analysis. Belsley et al. (1980) suggest that VIF's greater than 10 represent a potential collinearity problem. The highest computed VIF in this sample was 1.80, leading us to conclude that collinearity is not a serious issue.

Table 1. Descriptive Statistics

	Mean	Std. Dev.	Minimum	Maximum
IT ₀ /Sales ₁	0.0242	0.2100	0.00	0.26
Earn ₁ /Sales ₁	0.0524	0.0626	-0.69	0.31
SDEarn / Sales ₁	0.0298	0.0314	0.00	0.31
Number of Segments	2.6464	2.0685	1.00	10.00
Industry Concentration	0.6533	0.2327	0.14	1.00
Transform Strategic IT Role	0.1589	0.3657	0.00	1.00
Size	8.1502	1.2592	2.93	11.70
N = 1598				

Table 2. Correlation Table

	IT ₀ / Sales ₁	Earn ₁ / Sales ₁	SDEarn/ Sales ₁	Number of Segments	Industry Concentration	Transform
Earn ₁ /Sales ₁	0.225*					
SDEarn/Sales ₁	0.190*	-0.149*				
Segments	-0.082*	0.048	-0.160*			
Industry Concentration	-0.114*	-0.290*	-0.138*	0.156*		
Transform Strategic IT Role	0.301*	0.219*	0.056	-0.167*	-0.170*	
Size	0.129*	0.463*	-0.138*	0.232*	-0.135*	0.096*

N = 1598

*Correlation is significant at 0.01 level (two-tailed test).

Table 3 provides the regression results for both the levels of IT investment (Panel A) and for changes in IT investment (by controlling for the prior year's IT budget (IT₁/Sales₁)) (Panel B). We show both sets of results to show the robustness of our results. The discussion of the results revolves primarily around panel B, which incorporates the prior year's IT budget. Firm size (size) was not a significant control variable in the regressions. For clarity, the findings for interactive hypotheses between IT strategic role (transform) are presented together with main effects for the firm and environmental context hypotheses.

H1 Transformation Strategic IT Role: Main Effects Only. The main effect for the transformation strategic role of IT is positive but not statistically significant (p. < .20). As we shall see, it did, however, have significant interactive effects with the level of earnings, diversification, and industry concentration.

Table 3. Regression Results: Determinants of IT Expenditures

$$IT_0 / Sales_{-1} = \alpha_0 + \alpha_1 IT_{-1} / Sales_{-1} + \alpha_2 Transform + \alpha_3 Earn_{-1} / Sales_{-1} + \alpha_4 Segments + \alpha_5 Ind Concentration + \alpha_6 SDEarn_{-1} / Sales_{-1} + \alpha_7 Size + \alpha_8 Transform * Earn_{-1} / Sales_{-1} + \alpha_9 Transform * Segments + \alpha_{10} Transform * Ind Concentration + \alpha_{11} Transform * SDEarn_{-1} / Sales_{-1} + \epsilon$$

Panel A: Regression Results (without lagged IT expenditures as an explanatory variable)

Variable	Coef.	p-value	Coef.	p-value
(Constant)	0.017	0.00	0.016	0.00
Transform	0.012	0.00	0.026	0.00
Earn ₋₁ /Sales ₋₁	0.069	0.00	0.064	0.00
Segments	-0.000	0.31	0.000	0.35
Industry Concentration	0.006	0.02	0.008	0.00
	0.125	0.00	0.132	0.00
SDEarn/Sales ₋₁				
Size	0.000	0.86	0.000	0.76
Transform * Earn ₋₁ /Sales ₋₁			0.020	0.33
Transform * Segments			0.001	0.55
Transform * Industry Concentration			-0.022	0.00
Transform * SDEarn/Sales ₋₁			-0.105	0.05
Model F		12.448		11.783
Adjusted R ²		22.3%		22.9%
N = 1598				

Panel B: Regression Results (with lagged IT expenditures as an additional explanatory variable)

Variable	Coef.	p-value	Coef.	p-value
(Constant)	0.008	0.06	0.009	0.04
IT Expenditures ₋₁ /Sales ₋₁	0.472	0.00	0.466	0.00
Transform	0.007	0.00	0.007	0.19
Earn ₋₁ /Sales ₋₁	0.043	0.00	0.033	0.00
Number of Segments	0.000	0.72	0.000	0.77
Industry Concentration	0.006	0.01	0.007	0.01
SDEarn ₋₁ / Sales ₋₁	0.061	0.00	0.060	0.00
Size	-0.000	0.93	-0.000	0.92
Transform * Earn ₋₁ /Sales ₋₁			0.049	0.02
Transform * Number of Segments			0.003	0.00
Transform * Industry Concentration			-0.017	0.02
Transform * SDEarn / Sales ₋₁			-0.000	0.99
Model F		24.601		23.230
Adjusted R ²		49.5%		50.6%
N = 892				

Dependent Variable = IT₀/Sales₋₁

Note: For brevity, industry and annual dummies are included in these models but not tabulated.

H2 and H6 Level of Earnings: Main and Interactive Effects. The data provide strong support for both main and interactive effects. Firms with higher earnings spend more on IT ($p < .01$) suggesting that firms that have more discretionary funds are able to pay more for information technology. Firms with high earnings in transformative industries have even higher IT budgets ($p < .03$). This suggests that firms in an industry where IT transformation is critical, firms commit an increasing share of their discretionary funds to information technology.

H3 and H7 Diversification: Main and Interactive Effects. Diversification's effects are not consistent but vary across industry type. The main effect (H3) is not significant ($p < .77$), while the interactive effect with transformative industry is highly significant at $p < .001$ (H7). Diversified firms in industries where IT is transformative have higher IT budgets.

Within transformative industries, this is consistent with the findings of Dewan et al. (1998), who did not consider IT's strategic role, but found significant main effects for related diversification, and marginally significant main effects for unrelated diversification. The lack of findings in non-transformative firms may in part be due to the different measures used for diversification in the two studies. Dewan et al. examine the weighted average share of sales made within and outside the same two-digit Standard Industry Code (SIC), while this study uses the number of different segments used for financial reporting and does not discriminate between related and unrelated diversification.

H4 and H8 Industry Concentration –Main and Interactive effects

The data provide support for main effects of industry concentration (H4) ($p < .01$), but the negative interactive coefficient contradicts H8 ($p < .02$). Firms in non-transformative industries increase IT budgets as the industry becomes more concentrated, but this is reversed in transformative industries: more concentrated industries have lower IT budgets. One possible explanation is that returns to IT investments can have a fundamentally different form in transformative industries: rather than being fixed, leading to a zero-sum redistribution, they may increase as more competitors pursue IT-enabled innovation. This often occurs in situations where industry-wide IT standards are important, e.g., the cargo industry, as they provide for an industry-wide technology platform from which IT-enabled innovations can be launched. Less concentrated industries may be more likely to both adopt industry-wide standards (since small groups of competitors have less power to block industry-wide adoption than do a few large, powerful competitors) leading to greater industry-wide process innovation. Thus, the non-zero sum benefits of IT-enabled transformation may be more likely to be exploited in less-concentrated industries. Empirical investigation of this possibility is an opportunity for future research.

H5 and H9 Volatility of Earnings – Main and Interactive effects

The data provide strong support ($p < .001$) for the main effect of earnings volatility (H5); however, they indicate that these effects do not vary by strategic IT role (H9) ($p < 1.00$).

Taken together, the interactive effects suggest that managers increase IT spending more in transformative industries to manage complexity, i.e., diversification (H7), and opportunity, i.e., earnings level (H6), arising from internal sources but not from more externally-driven factors, such as industry earnings volatility (H9).

6 DISCUSSION AND CONCLUSION

Finding that the transformative and non-transformative industry-level strategic roles of IT result in different levels of IT spending supports Orlikowski and Iacono's (2001) contentions that IT is not homogeneous and that much still remains to be learned about the IT artifact. This suggests managers should assess, among other things, whether their IT strategies, and hence their IT expenditures, are framed within an industry (or subindustry) undergoing IT-enabled transformation. Such an observation is an enhancement to prior budget models (e.g., Gurbaxani et al. 2000), which link IT spending to the annual rate of improvement in IT hardware but do not address the nature of the business contexts within which IT spending occurs.

In examining the appropriateness of their IT budgets, most organizations contrast various IT budget metrics to selected benchmark firms. Our findings suggest that it is critical that these benchmark firms exist in business environments similar to the focal firm. In addition to the industry (or subindustry) strategic role of IT, benchmark firm selection procedures should also consider industry-level factors such as industry concentration and market volatility. This provides support for the well-known tendency of managers to set IT budgets based on industry-wide percentage-of-sales benchmarks. These results indicate that, while helpful, such an approach is incomplete. Firm-level factors such as diversification and the firm-specific component of earnings levels and volatility

also affect budgets in ways that are generalizable across firms. Finally, it was also observed, not surprisingly, that IT budget expenditures were associated with a firm's (prior year's) earnings. Clearly, firms are being opportunistic with regard to IT. When additional funds are available, some portion of these additional funds is directed toward IT-related expenditures. Thus, even though appropriate benchmarking is performed, a strict adherence to industry budget ratios (independent of a firm's market opportunities) is likely to prove dysfunctional.

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