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TECHNOLOGICAL COMPLEXITY: A TOOL FOR UNDERSTANDING THE BEHAVIOUR OF CONSUMERS OF HIGH VALUE-ADDED FOODSTUFFS

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Abstract. This article proposes and develops the concept of technological complexity (TC) as a useful and simple tool for grouping key attributes that give added value to a product. In addition, it reports an empirical application of this concept to two different food products (cured ham and cured sausage). The authors used a mixed-effects multinomial logistic regression model and show that in the cured pork product agribusiness, a low frequency of consumption favours the acceptance of high TC products. The results also confirm that marketing high TC products in stores with a large assortment decreases the chances of success for agribusiness companies that produce cured pork food products. These finding can be used by the managers for designing complementary attributes that improve their product portfolio. Besides, advertising expenditures associated with introducing new products could be reduced if companies strengthened their presence in specialty stores.

Keywords: agribusiness entrepreneurship, competitiveness, differentiation, agrifood marketing, strategy, technology management.

JEL Classification: M10, M21, M31, Q13.

Introduction

Managers must make decisions with high levels of uncertainty, especially in increasingly competitive environments in which product differentiation represents a common strategy. Such differentiation enables companies to market higher value-added products that provide economic benefits and improve the welfare of consumers of these products. To achieve such a strategy, the managers must understand consumer behaviour sufficiently to enable them to design new products that satisfy customers better or continue

producing traditional products that are highly valued by a segment of the population, such that they offer high value-added products. In the agribusiness sector in particular, Davčik (2010, 2013) notes that the added value of newly developed foodstuffs is a critical factor and can be enhanced through the use of a brand strategy.

Yet as Fader and Hardie (1996) assert, consumers select stockkeeping units (SKUs), not brands. A SKU is a single unit of a product whose specific attributes differentiate it from other offerings. Fader and Hardie (1996) recommend analyses at the SKU level, as useful to manufacturers, retailers, and researchers. Thus, SKU choice models have emerged with increasing frequency in marketing research (Bell *et al.* 2005; Ho, Chong 2003; Inman *et al.* 2008; Singh *et al.* 2005), with theoretical foundations in economics (Lancaster 1975, 1991) and psychology (Simon 1956). However, these models suffer from significant computational complexity in their estimations and fail to comply with the law of parsimony, or Ockham's razor, which establishes that the simplest solution is usually the correct one. Moreover, SKU choice models often require access to large databases, putting them beyond the reach of many researchers and managers. Yet Inman *et al.* (2008) warn that in models of consumer behaviour, the most appropriate level of analysis is the consumer's choice of product attributes. Therefore, we ask ourselves; how grouping key attributes that give value added to a product in a simple way? how some consumer features can influence on the decision to buy high value-added products? We propose focusing on a product's technological complexity (TC) as a means to study the factors that affect consumer preferences for products with high TC (i.e., high value-added products). Then we apply our approach empirically to the food industry. From the results of these analyses, we derive some conclusions and managerial implications.

1. Technological complexity

According to Lancaster (1975, 1991), consumers have no preference for a particular product (e.g., a car) but have preferences for one or more of the attributes of the product (e.g., colour, leather seats). In the agribusiness sector, such preferences refer to specific characteristics that consumers have learned they prefer, such as taste or tenderness. Considering that Davčik and Rundquist (2012) show that consumer perceptions of brand quality can drive firms' success in the market, we posit that Lancaster's theory might be congruent with consumer behaviour in the food industry.

Bell *et al.* (2005) explain that the vast range offered in product categories consists of thousands of SKUs, which poses a major challenge to researchers and store managers, who must decide what to offer within each category. Three main perspectives exist to deal with this challenge. First, models can estimate each SKU-level parameter as a fixed effect, resulting in a considerable loss of degrees of freedom, which can create problems if there is high volatility in the database as a result of the entry and exit of SKUs over time (Bucklin, Gupta 1999). Second, Fader and Hardie (1996) suggest isolating specific features of the product through panel data, so that they can explore categories with many alternatives using just a few stable, cross-product attributes (e.g.,

size, flavour, shape). Third, simple, aggregated models can provide an initial approach, leading to more complex models. Payne *et al.* (1993) show that consumers do not take all available information about a product into account before making a final purchase decision. Instead, they consider a limited number of alternatives at the time of purchase (Jedidi, Kohli 2005). Therefore, Inman *et al.* (2008) suggest that it should be possible to reduce the number of SKUs being considered.

We propose the degree of preference for TC as an alternative means to simplify SKU models for mass-market products. The purchase of these products often is periodic; the factor that guides the final decision is preference for the technological level of the attributes, which consumers know in advance. Attributes that consumers consider essential in the product that they normally purchase determine their decisions; in turn, we define TC as the combination of the technological levels of two or more attributes in a product, as outlined in Figure 1.

Attributes can be any property obtained by applying technologies in the production and product processing stages. Although we propose that TC combines two or more attributes, we do not claim that their relationship must be linear. Instead, it is appropriate to select attributes that, in the general appreciation of the market or at the discretion of business advisers or managers of each business sector, are the most valued and readily perceived by the customer in each category. Thus, TC brings together two or more product-specific attributes (e.g., colour, texture) to enable the reduction of the number of options to include in SKU models. For example, in the market for cured pork products in Spain, one of the features consumers appreciate is the sourcing, such that they prefer products produced using Iberian breed pigs (Attribute 1, pig's genetic potential). They also likely consider the level of acorn intake for this pig (Attribute 2, pig's feeding system). With these two features, we can define four main types of products for this industry: (A) cured products from Iberian-breed pigs fed with acorns; (B) cured products from Iberian-breed pigs fed with cereals mixed with some acorns; (C) cured products from Iberian-breed pigs fed with cereals; and (D) cured products from white-breed pigs fed with cereals. Each of these products implies a level of technological complexity that provides technical attributes that consumers prefer.

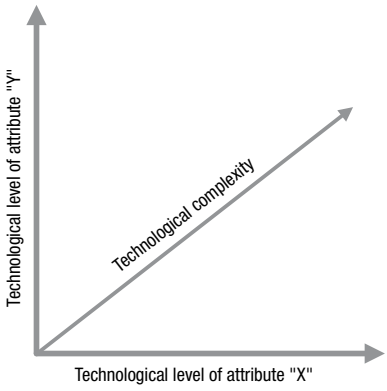

Fig. 1. Factors that define products' technological complexity

Consumers then buy higher or lower levels of technology, which means ultimately that the individual consumes technology. The level of TC of a product thus supports connections across the main implicit attributes of a product, which can achieve a simplification of SKU choice models. At this point, we also offer three clarifications. First, the number and type of product attributes can be defined in each industry according to needs and experience of managers or researchers. Second, the proposed TC concept does not mandate that the product is new to the market;

rather, it means that during production, the combination of technologies differentiates the outcome from other products in its category, which makes it greatly valued by some market segment. This distinction is what we mean when we refer to products with different levels of technological complexity, and the concept can apply to business strategies for products obtained through traditional technologies or practices (Cannarella, Piccioni 2011), as well as for those obtained through technological innovations (Mortara, Minshall 2011). Third, preferences for a certain degree of complexity in products differ from preferences for a certain quality or brand. The same level of complexity comprises a wide range of grades and brands, so a preference for a low level of TC is not equivalent to a preference for a low-quality product or brands with low perceived quality. The importance of product quality can influence preferences for a certain level of TC, but ultimately, it is the level of technology consumers seek, not the level of quality the product offers. According to the normal logic of the purchasing process, consumers first select the product attributes (TC level) that suits their needs, then choose quality, brand, and other aspects that conform to their preferred consumption behaviour.

Furthermore, the TC concept implies the presence of a "T factor," from which it is possible to establish a gradient of magnitude to establish high, medium, or low TC according to the technological attributes that consumers prioritize. For example, for cured pork products, a product (A) has the highest level of complexity, because it comes from an Iberian pig (Attribute 1) whose feeding system featured acorns (Attribute 2), which are both traditional production technology factors. These factors, in accordance with the global trend of valuing traditional agricultural production systems (Cannarella, Piccioni 2011), cause consumers to perceive the high value of (A) products. On the flip side, consumers consider products from white-breed pigs, fed cereal, as having the lowest level of complexity, because they largely question industrial-scale agricultural production systems (Cannarella, Piccioni 2011). Many alternatives also fall between these extremes, and to the extent that they approach either extreme, they could be classified as medium-high (B) or medium-low (C) levels. Similarly, we can establish a gradient of TC levels for products in other categories. To do so, we must start by setting the extremes of TC, then determine intermediate complexity levels according to their proximity to either extreme. For example, there are differences among cured white-breed pork products, as Resano *et al.* (2012) outline, but for this research, their distinction is not pertinent.

From this gradient of TC, we can determine that a product with high TC implicitly has a greater added value than a product with low TC. According to Katz and Boland's (2000: 716) definition, "value-added refers to the collection of activities within a company or industry resulting in the creation of a product or service valued by the consumer", and there is perpetual demand to increase the added value of products. For example, one of best ways to achieve customer satisfaction is through product customisation which can increase consumers' willingness to pay higher prices for the products that they buy (Cotes 2010; Jiao *et al.* 2003; Muñoz, Cotes 2011). Added value in agribusiness chains may be associated with options supplied through various agricultural production methods, health or environmental concerns (organically certified), animal welfare,

geographical origin, processing stage, packaging, food aesthetics, marketing channels, food properties, delivery service, and legal or political obligations (Astner *et al.* 2011; Lepper-Blilie *et al.* 2014; Ravindran, Jaiswal 2016). Further added value in agribusiness chains accrues to not only consumers but also farm communities and their development (Alonso 2011; Guthrie *et al.* 2006).

2. Framework and hypotheses

To exemplify an application of the TC concept, in Figure 2 we display the factors that we consider influence consumer preferences, according to the level of TC of the product.

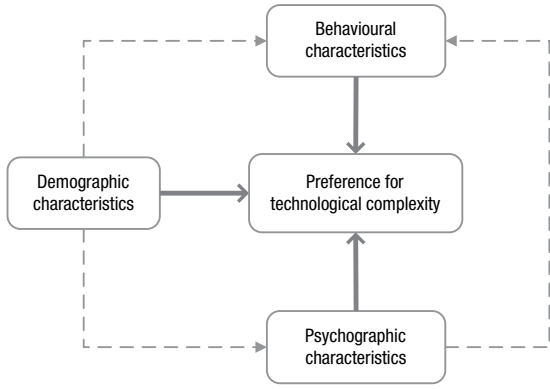

Fig. 2. General model of preference for product technological complexity

In particular, demographic characteristics have both direct and indirect effects on preferences for TC (through their influence on consumers' psychographic and behavioural characteristics). To take the first steps in explicating and applying TC though, we focus in this article on the direct effects of demographic and behavioural characteristics (solid arrows), leaving direct and indirect psychographic effects and indirect demographic effects to other research.

2.1. Demographic characteristics

According to Mathur *et al.* (2006), different approaches to defining consumer life cycles agree that the current experience or anticipation of certain events in life, as well as the point in time at which they occur, should affect people similarly with regard to their consumption patterns. These life experiences thus offer better predictors of consumer behaviour than applying segmentation models based on age. We anticipate that relationships among different variables approximate the constitution of a household and the consumer's motivation to acquire food with high TC. For example, household members younger than 7 years of age offers an indirect indicator of a household that has experienced a relatively recent birth; the number of household members between 7 and 17 years of age might indicate a more established family, in a more mature parenting stage. On the other end, many household members between the ages of 44 and 62 years

may indicate impending retirement. However, we make no a priori assumptions about the relationship between TC foodstuffs and these indirect measures of the consumer's life cycle, or with classic demographic variables (e.g., income, education, age, employment status, gender). Instead, this study serves to explore the potential effects of these preferences on the TC of a product and contribute to identifying the characteristics and needs of consumers, which should improve provide guidance for devising a successful business strategy.

2.2. Behavioural characteristics

2.2.1. Purchase frequency

One of the behavioural characteristics that might affect a consumer's preferences for TC is consumption frequency. McAlister, Pessemier (1982) and Kahn (1995) claim that the search for variety is intrinsically motivated by satiety/boredom, together with a desire for novelty and curiosity. A variety-searching profile of the household member responsible for purchases prompts purchase decisions that provide greater variation. Moreover, in any given period of time, the needs of the consumer unit may differ, and this change also is reflected in each consumer's purchasing behaviour. With shorter times between purchases or a greater intensity of consumption, consumers become satiated faster, and the need for variety to escape the routine becomes more important (Park *et al.* 1991). Thus, we formulate the following hypothesis:

H1: If the time between purchases is short, preference for TC products is greater.

2.2.2. Retail store format

Prior food sector research (Boatto *et al.* 2011; Mirosa, Lawson 2012; Meixner, Knoll 2012; Nijhoff-Savvaki *et al.* 2012) indicates that the main factors that influence store choices are a location convenient for the consumer, low prices, and the offer of a wide range of products. Levy and Weitz (2004) note that store size offers an indicator of the product selection by the distributor, determined by the number of categories and number of items within each category. However, most food supply chains have very similar categories, so the differences in the level of selection largely depend on the assortment of products within each category (Briesch *et al.* 2009). Thus, we formulate the following hypothesis:

H2: If consumers prefer retail store formats that feature a high variety of products, their preference for high TC products is higher.

3. Methodology

To test our hypotheses, we studied two different products (cured ham and cured sausage) within the cured pork food sector. Both products are marked by commercial supply lines with the four TC levels we explicated previously (A–D); in addition, they rely on the same commodity (pork meat) but engage in completely different processing and final presentation methods. Thus consumers should seek the key attributes of these products (i.e., those that give rise to the four TC levels), but the product itself should not affect their behaviour. We obtained 315 valid surveys from cured ham consumers and 254

from cured sausage consumers of six distribution chains, located in the city of Valladolid (Spain). The surveys were conducted within each store and referred to the selection of cured products, so we only interviewed people who placed a cured pork product in their shopping cart. We also confirmed that they were usual buyers of this product for home use, which ensured their adequate knowledge of the product category. The interviews themselves were conducted in Valladolid, Spain, which offers representative characteristics for Spain in terms of its medium size, income per capita, and consumer habits (Torres 2009). Thus we obtained a sample where the 11.07% were consumers 18–30 years of age, the 75.40% were over 30 years of age but under 62 years of age and the 13.53% were over 62 years of age. In terms of theirs employment situation the 58.35% received income for their work, the 31.28% were exclusively housewives or retirees and the 10.37% was unemployed or had a different situation than the above mentionated. About monthly income, 18.41% of the household where lived these consumers had income below the 1.200 €, the 53.25% earned from the 1.200 € until the 2.100 € and the 28.34% had monthly incomes above the 2.100 €. Finally, 72.64% of the main shopper were women and 27.36% were men.

Store selection is a random variable for the Valladolid market, so we analysed the data using a mixed linear model for multinomial variables, with a nominal generalised linkage function:

$$P(Y_{psi} = j) = \frac{e^{u_{psij}}}{1 + \sum_{m \neq j^*}^{3} e^{u_{psim}}}, \tag{1}$$

where $P(Y_{psi} = j)$ was the probability that the *i-th* consumer who buys the *p-th* product in the *s-th* store will choose a product with the *j-th* level of TC. Here, $j \neq j^*$, such that $j = \{1,..., 3\}$ and j^* represents the level of TC taken as a reference, namely, products from white-breed pigs fed with a cereal mixture (D). Such products have a lower level of TC in the category of cured pork food but also offered the most observations. We use *m* to refer to the level of TC that differs from the reference level j^*. Thus we can determine u_{psij} by:

$$u_{psij} = \mu_j + \sum_{d=1}^{5} \beta_{dj} x_{psid} + \sum_{k=1}^{6} \gamma_{kj} + \psi_{pj} + \varphi_{sj} + \xi_{spj}, \tag{2}$$

where u_{psij} is the choice of a product with the *j-th* level of TC of the *p-th* product in the *s-th* store by the *i-th* consumer. In a generalised logit transformation, μ_j represents the intercept on the *j-th* level of TC, and β_{dj} is the fixed effect of the quantitative variable demand $d = \{1,..., 5\}$ in the *j-th* level of TC. Furthermore, x_{psid} offers the observation of the *d-th* quantitative demand variable in the *p-th* product in the *s-th* store of consumer $i = \{1,\ldots, n_{ps}\}$; γ_{kj} is the fixed effect of the qualitative demand variable, $k = \{1,..., 6\}$ in the *j-th* level of TC; ψ_{pj} is the random effect of the *p-th* product with the *j-th* level of TC; φ_{sj} reflects the random effect of the *s-th* store in products with the *j-th* level of TC; and ξ_{spj} stands for the random effect of the *s-th* store in *p-th* product with the *j-th* level of TC.

We analysed demographic and behavioural data for both our quantitative and qualitative measures. Specifically, the quantitative variables featured age data (number of household members under 7 years of age, 7–17 years of age, 18–30 years of age, 31–43 years of age, 44–62 years of age, and older than 62 years of age) and the time between purchases, measured by the number of days). The qualitative variables were educational level, monthly household income, employment status, age of the buyer, and gender, as well as preferences for a certain type of store.

Finally, we considered the size of the store as a proxy for the level of product assortment. Thus hypermarket formats have the greatest variety, an assumption confirmed by reports by Información Comercial Española (2007). Supermarkets have the second greatest variety. With a greater variety of products, it seems logical to expect a greater range of products with different TC levels; therefore, consumers who wish to acquire products with high TC should prefer the hypermarket distribution channel.

4. Results and discussion

Using the research methodology we presented in Figure 3, we derive a general model to explain how some demographic and behavioural characteristics influence consumers' preferences for products with high TC (Table 1) with a Log Pseudo-Likelihood of 6542.88.

It is worth mentioning that, with the exception of household members from 7 to 17 years of age, none of the demographic variables had significant effects ($p < .001$), so for ease of exposition and space considerations, we do not present their parameters separately in Table 1. In terms of explaining a preference for more complexity, more household members between 7 and 17 years of age reduces the chances that the household chooses a product with intermediate TC (i.e., product B, $p = 0.0122$), but we found only moder-

Table 1. Preference model for consumers of cured pork products according to levels of technological complexity

Effect	TC[a]	Estimate	Standard error	Pr > |t|
Intercept	A	–0.8299	0.8402	0.3238
	B	–1.6308	0.7930	0.0410
	C	–1.3642	1.0855	0.2128
	D	0	.	.
Number of household members 7–17 years of age[b]	A	–0.3350	0.2149	0.1196
	B	–0.6508	0.2587	0.0122
	C	–0.7714	0.3276	0.0189
	D	0	.	.
Interval between purchases	A	0.0101	0.0025	<.0001
	B	0.0100	0.0026	0.0001
	C	–0.0042	0.0055	0.4421
	D	0	.	.

End of Table 1

Effect	TC[a]	Estimate	Standard error	Pr > |t|
Store preference (specialty stores[c])	A	0.5850	0.3017	0.0536
	B	0.6669	0.3287	0.0436
	C	0.9108	0.4559	0.0463
	D	0	.	.
Store preference (supermarkets)	A	–0.2490	0.3146	0.4291
	B	0.3698	0.3143	0.2403
	C	0.2237	0.4756	0.6383
	D	0	.	.
Store preference (hypermarkets)	A	0	.	.
	B	0	.	.
	C	0	.	.
	D	0	.	.

	TC[a]	Estimate	Standard error	Z value	Pr Z
Variance of ψ_{pj}	A	0	.	.	.
	B	0.0145	0.1011	0.14	0.4443
	C	0.1694	0.3493	0.48	0.3156
	D	0	.	.	.
Variance of φ_{sj}	A	0.0829	0.0982	0.84	0.2005
	B	0.0038	0.1952	0.02	0.4920
	C	0.4804	0.5159	0.93	0.1762
	D	0	.	.	.
Variance of ξ_{spj}	A	0	.	.	.
	B	0.2168	0.2172	0.10	0.4602
	C	0.2405	0.3627	0.66	0.2546
	D	0	.	.	.

Notes: [a]Technological complexity classification: A = cured products from Iberian-breed pigs fed with acorns; B = cured products from Iberian-breed pigs fed with cereals-mixed-rations and some acorns; C = cured products from Iberian-breed pigs fed with cereals-mixed-rations; D = cured products from white-breed pigs fed with cereals-mixed-rations; [b]For ease of exposition and space considerations, we do not present the parameters for other demographic variables, which had no significant effects; [c]Butchers, delicatessens, and other outlets.

ated significant differences ($p = 0.0189$) for product (C), and no significant differences in the comparison with products with the highest levels of TC ($p = 0.1196$). Thus we offer a first approximation of the effect of demographic variables at the moment a consumer chooses complex food products and we give additional evidence about demographic features could be a weak factor to explain of behavior of the food consumer as has been suggested by some researchers (Cotes-Torres *et al* 2015; Uncles *et al* 2012).

The products that offer intermediate TC appear sensitive to the life cycles of families raising young children but not babies. This demographic feature does not influence preferences for products with low or high levels of TC though.

A longer interval between purchases increases opportunities ($p < 0.0001$) to prefer products with high TC (A) over white-breed pig cured products. A similar increase ($p = 0.0001$) occurs in terms of preferences for products with a medium-high level of TC (B) compared with the same reference point. Thus for Iberian pig cured products, there is no evidence in support of H1. Regarding the effect of the consumer's store preference, in Table 1 we find no significant differences between consumers who prefer to purchase products in supermarkets or hypermarkets. However, moderated differences emerged when we also included specialty stores, though different than our expectations. That is, consumers who preferred specialty stores had a greater tendency to prefer products with high TC, in contrast with those who preferred to shop for products of low complexity in hypermarkets. As Sanjuán *et al.* (2006) explain, for Spanish consumers of Iberian pork products, the views and recommendations of their butcher often provide the most important purchase determinant. Pettijohn *et al.* (2002) concur that recommendations made by sales staff influence consumer choice. Perhaps consumers, who prefer to buy at butcher shops, believe that following the butcher's recommendations allows them to obtain the best possible cured product (high TC). We must reject H2.

Finally, all the random effects were non-significant, so being a consumer of ham did not generate significant variance on the four levels of TC analysed compared with the variance found among cured sausage consumers (ψ_{pj}), and there was no significant source of variance among products with different complexities acquired at the same store (φ_{sj}). Nor did we find any significant difference in the variance among consumers of ham or cured sausage with different complexities who acquired these products in same store (ξ_{spj}). In other words, the fixed effects obtained in the model (household members between 7 and 17 years of age, interval between purchases, preferences for specific stores) can be extrapolated to all products sold in the Spanish cured pork products food category.

Conclusions

The novel proposal to simplify SKU models, using the level of TC as a valid factor to collect various product attributes not only is consistent with economic principles but also is helpful to marketers, particularly those working for smaller firms, where the availability of large databases, is often not possible. The concept can be applied easily to various product categories, suggesting some generalisability of the results. On the other hand, corporate business strategies usually seek to design new products for specific market niches, according to their demographic characteristics. This study instead challenges the usefulness of these features, especially for identifying the behaviours of

consumers of products with high TC (high added value). Thereby, for future research should explore demographic characteristics different to the traditional or replacing them with psychographic characteristics directly related to preferences for products with high added value; such as propensity to value extrinsic attributes (and intrinsic) or sensitivity to promotional discounts.

Consumption frequency is an important factor to consider in determining consumers' level of preference for complex products. In Spanish cured pork industry people who consume the product at a lower frequency are more sensitised to purchasing products with high TC; this can be used by the managers for designing complementary attributes that improve their product portfolio; for example: special small packaging, which will make them not only different from their competitors, but also will allow them to reduce their production costs; or carry out a plan of promotions that allow frequent consumers access to best prices by accumulation of shopping; encouraging the consumption of products of high TC.

Besides, we figure out that to increase the chances of success in launching new products with high TC, attention instead should centre on specialty stores. Consumers who prefer to buy in these stores have a particular interest in complex products, this is useful for the management of the companies because a greater emphasis on these marketing channels could increase efficiency and reduce the advertising expenditures associated with introducing new products. It also take better advantage of word-of-mouth effects, which tend to be very important in terms of influencing decision making by consumers of products with high TC. Future research, could study the interaction both the purchase frequency and retail store format preference; thus we combine two relevant decisions in consumer behavior: how often he/she will buy? (spare time) and; what retail store format he/she go? (for each commercial format, different shopping cart) which could affect the purchase of high TC products.

A limitation of this study was that it used only products of pork agribusiness, which benefits from the strong cultural roots that their products have in Spaniards; so it would be interesting to test whether the culture of a country itself can be a factor that changes preferences to buy products with high added value. Further research also could investigate products outside the food industry to uncover empirical evidence to support the generalisation of our findings to other settings.

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