Frequent Flier Program Partnerships, Substitutability, and Airlines' Profit

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Abstract

This paper offers a first model of parallel frequent flier programs partnerships, rather typical for the US domestic market. We model these partnerships as arrangements which make carriers' services more substitutable, in a setup where consumers value frequency and exhibit varying degrees of brand loyalty. We show that joining frequent flier programs can increase profits of partner airlines, even where no explicit coordination between them is allowed.

Keywords: Frequent Flier Programs, Airline Consolidation, Substitutability

JEL Codes: D43, D49, L13, L29, L40, L93

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1. Introduction

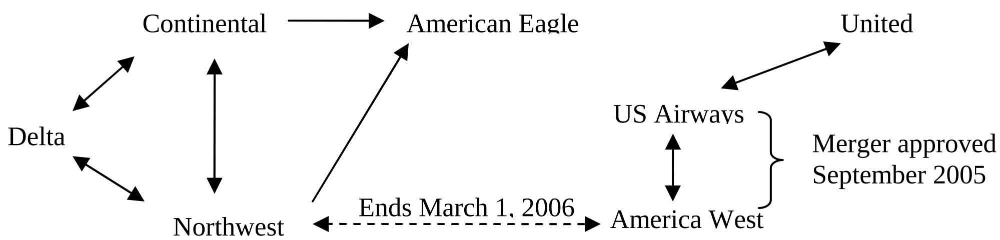
One of many forms of airline consolidation involves frequent flier program (FFP) partnerships. Those usually allow passengers to earn and/or redeem miles with flights of the partner airline. Major international code-sharing agreements, started in the 1990s on the transatlantic market, included FFP partnerships pretty much by default. In this case, joining frequent flier programs was a way to reinforce the complementary alliances between carriers. Indeed, being able to earn and (especially) redeem miles for international services with partner airlines increased value of airline's frequent flier program for domestic customers. A business traveler could now redeem miles earned traveling domestically with, for example, Delta, for a vacation abroad to locations where Delta does not fly but its partners do.

In late 1998 US carriers started forming domestic alliances, and joined their frequent flier programs. Benefits from such a strategy are actually not as obvious as from international partnerships. Even though US carriers may not be directly competing on many non-stop routes (since most large network carriers have their hubs in different airports), they do compete on many city-pair markets[2]. So, FFP partnerships between the US carriers appear more parallel than complementary.

As Lederman (2003) correctly points out, such partnerships are likely to increase substitutability between partner airlines' services, which is not a result carriers would like to get. Moreover, the practice of domestic FFP partnerships has survived up to now, as can be seen from Figure 1. As that figure shows (or rather, as it does not show), American Airlines is the only major network airline in the US, which is currently staying out of partnering with US carriers. While Continental and Northwest customers can earn miles on a limited number of American Eagle's services to/from Los Angeles international airport, American Airlines does not allow its frequent fliers to earn or redeem AAdvantage® miles on flights by any other US carrier. We therefore wonder whether there is any way in which carriers can actually benefit from parallel frequent flier program partnerships, even though such are likely to reduce substitutability between their services. It is possible that carriers join their frequent flier programs to compete with

[2] Lederman (2003) concluded that for first US FFP partnerships only about 10% of non-stop routes overlapped between partners; while for city-pair markets the overlap reached 47%.

other similar airline partnerships. In this case, a consumer choosing between two joint frequent flier programs may value the one which gives him/her more earning and redemption options higher. This may positively affect joint market share of the partner airlines. Yet, fiercer price competition between the partner airlines due to higher substitutability between their services can lead to adverse consequences for carriers' profits. One should keep in mind that while airlines on the US domestic market can form partnerships and join their frequent flier programs, it is also true they are not allowed to jointly set prices or frequency of service.



Excludes largely complementary partnerships with Alaska and Hawaiian. Continental-American Eagle and Northwest-American Eagle partnerships are limited to selected routes and not reciprocal (American Eagle customers cannot earn/redeem miles on Continental or Northwest)

Figure 1 FFP Partnerships involving US network carriers (as of October 2005)

Source: Airlines' web-sites

This paper offers a first attempt to model parallel frequent flier program partnerships as arrangements that increase substitutability between partner airlines' services by reducing the extent of consumers' brand loyalty. We model the case as a simple duopoly with competitors choosing frequency at the first stage of the game and price at the second. Consumers care about frequency and exhibit varying degree of brand loyalty. We modify model originally proposed by Hassin and Shy (2006). In that model, the authors consider effect of a parallel code-sharing agreement between airlines on prices and carriers' profits. Consolidation between airlines in that model does not affect frequency choice, nor is substitutability between partners' services changed; yet, consumers' reservation utility increases following the partnership. Thus, Hassin and Shy's result of higher prices and carriers' profits following consolidation does not look striking. Finally, Hassin and Shy assume carriers set frequency jointly following the partnership, which is a highly unlikely scenario on the US market, where (semi)-parallel FFP partnerships are observed.

Analysis of the model shows that lower substitutability results in lower equilibrium fares, as expected. Yet, equilibrium frequency of flights also decreases; effect on individual carrier's total profit is therefore ambiguous, while total welfare on the market necessarily falls. We thus offer a setup, under which parallel FFP partnerships can give airlines higher total profit. It is important to note that while we tie our model to the FFP partnerships story, we do not model consumers as making repeated purchases. Also, our exercise does not reflect such features of FFP as increasing marginal value of FFP points/miles and non-linearity in structure of awards. The goal of this analysis is showing that even strictly parallel FFP partnerships can be beneficial for airlines, even if they make their services closer substitutes and where explicit coordination between the partners is not allowed.

Frequent flier programs have been previously modeled largely in context of additional market power they offer to airlines. Borenstein (1996) showed how an airline can use FFP to deter entry on one of the two markets it serves. Cairns and Galbraith (1990) suggest the role of frequent flier programs as a device to establish 'artificial compatibility' between carrier products.

Empirical analysis of FFP partnerships can be found in works by Mara Lederman. Lederman (2003) examines to what extent FFP partnerships on US domestic market are parallel and how they affect demand. She finds that, first, partnerships do increase earning and redemption opportunities for some passengers; and second, partnerships appear to affect partners' demand positively (airline's market share at an airport increases with an increase in size of operation by the partner carrier). Lederman (2004) investigates demand effects of international FFP partnerships. This paper finds the size of demand effect of such FFP enhancements is positively associated with airport dominance. Lederman (2005) shows that airline flying into an airport dominated by a certain carrier can gain from partnering with that dominant airline.

Also somewhat related to our work are studies of airline consolidation on the U.S. domestic market. This growing literature yields no clear consensus as to whether such partnerships benefit consumers. Bamberger et al. (2004) and Ito and Lee (2005) document lower prices following domestic code-sharing agreements and suggest consumers did benefit from consolidation. However, Armantier and Richard (2005) and

Whalen (2005) suggest ambiguous competition effects, while Armantier and Richard (2006) find that consumer surplus actually fell as a result of the Northwest – Continental alliance.

The rest of the paper is organized in the following straightforward way. Section 2 develops the model of airlines' frequency-then-price competition, and analyzes properties of its equilibrium with respect to substitutability parameter, which can presumably to change as a result of airlines' FFP partnership. Section 3 discusses model's results and concludes.

2. Model

Consider a simple frequency-then-price game between two airline companies, where consumers value higher frequency and are heterogeneous in their preference for the two carriers. Suppose passengers are uniformly distributed along the $[0,1]$ interval. Consumer located at point zero exhibits strongest loyalty to airline 1, while passenger at the other end of the interval is the most devoted fan of airline 2. Then, for a passenger located at point $x \in [0,1]$, utility he receives will be equal to:

$$U_X = \begin{cases} f_1 - \tau(f_2)x - p_1 & \text{if chooses carrier } 1 \\ f_2 - \tau(f_1)(1-x) - p_2 & \text{if chooses carrier } 2 \end{cases} \qquad (1)$$

Where f_i denotes frequency offered by a given carrier, and p_i is the price. We do not allow our consumer to choose an outside alternative, to make sure the market is always fully served[3]. The main innovation we introduce as compared to Hassin and Shy (2006) is allowing the degree of substitutability between the carriers' services to depend on competitor's frequency, so that $\tau'(f_{-i}) < 0$ and $\lim_{f_{-i} \to \infty} \tau(f_{-i}) = 0$. That is, as competitor's frequency increases, consumer views the two airlines' services as less differentiated, other things equal.

We will model a frequent flier program partnership between the two carriers as an event which makes the function $\tau(f_{-i})$ steeper, or increases substitutability between the partner airlines' services faster, other things equal. In the most extreme case, we can consider the product differentiation parameter τ independent of competitor's frequency

[3] In original model by Hassin and Shy the partially served subgame-perfect equilibrium does not exist.

before the partnership (analogous to the baseline treatment of Hassin and Shy), and dependent as described above afterwards.

On the supply side, we have two airlines offering identical services on the same market. The carriers choose prices after they have chosen the frequencies. All choices are made non-cooperatively; yet, carriers are aware of the impact of frequent flier program partnership between them on degree of substitutability between their products. The total cost of operation depends solely on frequency; namely, $C_i\left(f_i\right) = \delta f_i^2$, $i = 1,2$. We assume decreasing returns to frequency since higher frequency of flights increases congestion at an airport and the aircraft utilization rates (or may require using additional aircraft), other things equal.

To make the model more tractable, we impose a simple linear symmetric structure on the relationship between frequency of competitor's (and at the same time partner's) flights and the degree of substitutability between the carriers' products. Namely, we will work with:

$$\tau(f) = \tau_0 - \tau_1 f \qquad (2)$$

The following restrictions on parameters of (2) are sufficient to ensure positive equilibrium prices and frequencies.

$$\begin{aligned} &\tau_1 < 0.8 \\ &\tau_0 > \tau_1 \end{aligned} \qquad (3)$$

Given the above stated, (1) turns into:

$$U_X = \begin{cases} f_1 - (\tau_0 - \tau_1 f_2)x - p_1 & \textit{if chooses carrier } 1 \\ f_2 - (\tau_0 - \tau_1 f_1)(1 - x) - p_2 & \textit{if chooses carrier } 2 \end{cases} \qquad (4)$$

Clearly, τ_1 will be the most important parameter for our purposes. If $\tau_1 = 0$, we are back to the baseline treatment of Hassin and Shy (2006).

It is actually interesting to observe the mechanism behind increasing substitutability between the airlines' services with an increase in τ_1 (which is exactly what we assumed will happen once frequent flier program partnership is introduced). Consider a customer located at point zero (the one exhibiting the most loyalty to airline 1). His utility is given by:

$$U_X = \begin{cases} f_1 - p_1 & \textit{if chooses carrier } 1 \\ f_2 + \tau_1 f_1 - \tau_0 - p_2 & \textit{if chooses carrier } 2 \end{cases} \tag{5}$$

If $\tau_1 = 0$, airline 1 can increase both its frequency and price by one unit, keeping the difference between consumer's satisfaction with services of carriers 1 and 2 the same as before (other things being equal, of course). If τ_1 becomes positive, however, increase in frequency by airline 1 increases consumer's utility from flying with airline 2. Therefore, if airline 1 now increases both frequency and its price by one unit, the difference between consumer's level of satisfaction with services of carriers 1 and 2 will decrease. This precisely means that the two goods have become more substitutable (less differentiated) for our consumer.

As is typical for such models, we begin by locating the marginal consumer, or the one indifferent between flying with the two carriers. Due to assumed uniform distribution of consumers along the $[0,1]$ interval, the location of such consumer will also give us the market share of airline 1. Let us denote this location through $\hat{x}$. It is clear that for the marginal consumer the following equality must be satisfied:

$$f_1 - (\tau_0 - \tau_1 f_2)\hat{x} - p_1 = f_2 - (\tau_0 - \tau_1 f_2)(1 - \hat{x}) - p_2 \tag{6}$$

After simple transformation we obtain the following expressions for market shares of the two carriers, denoting them through s_1 and s_2:

$$\begin{aligned} s_1 &= \hat{x} = \frac{(1-\tau_1)f_1 - f_2 + p_2 - p_1 + \tau_0}{2\tau_0 - \tau_1(f_1 + f_2)} \\ s_2 &= 1 - \hat{x} = \frac{(1-\tau_1)f_2 - f_1 + p_2 - p_1 + \tau_0}{2\tau_0 - \tau_1(f_1 + f_2)} \end{aligned} \tag{7}$$

As we start solving the game by backward induction, we must first determine the prices the airlines will choose (in a non-cooperative fashion). The resulting solutions will be functions of frequencies, which we will substitute into the profit functions to obtain the solution of the first stage of the game. The profit functions of the two carriers will be:

$$\begin{aligned} \pi_1 &= p_1 s_1 = p_1\left[\frac{(1-\tau_1)f_1 - f_2 + p_2 - p_1 + \tau_0}{2\tau_0 - \tau_1(f_1 + f_2)}\right] - \delta f_1^2 \\ \pi_2 &= p_2 s_2 = p_2\left[\frac{(1-\tau_1)f_2 - f_1 + p_1 - p_2 + \tau_0}{2\tau_0 - \tau_1(f_1 + f_2)}\right] - \delta f_2^2 \end{aligned} \tag{8}$$

The first-order conditions at the second stage are:

$$\frac{\partial \pi_1}{\partial p_1} = \frac{(1-\tau_1)f_1 - f_2 + p_2 - 2p_1 + \tau_0}{2\tau_0 - \tau_1(f_1 + f_2)} = 0$$
$$\frac{\partial \pi_2}{\partial p_2} = \frac{(1-\tau_1)f_2 - f_1 + p_1 - 2p_2 + \tau_0}{2\tau_0 - \tau_1(f_1 + f_2)} = 0 \qquad (9)$$

Solving for equilibrium prices (as functions of frequencies) reduces to finding solution to the simple system of linear equations. The resulting solution of the second stage of the frequency-then-price game is:

$$p_1^*(f_1, f_2) = \frac{1}{3}\left[(1-2\tau_1)f_1 - (1+\tau_1)f_2 + 3\tau_0\right]$$
$$p_2^*(f_1, f_2) = \frac{1}{3}\left[(1-2\tau_1)f_2 - (1+\tau_1)f_1 + 3\tau_0\right] \qquad (10)$$

An interesting result is that if in equilibrium $f_1^* = f_2^* = f^*$, then the equilibrium price is:

$$p^* = \tau_0 - \tau_1 f^* \qquad (11)$$

So that, other things equal, higher equilibrium frequency will mean lower equilibrium prices. It is, however, early to claim unambiguously that higher degree of substitutability (larger τ_1) will also mean lower prices, since equilibrium frequency will itself be a function of this parameter.

Solving for the equilibrium frequencies appears a tricky task, since the resulting profit functions contain decision variables in both numerator and denominator. Substituting (10) into (8), taking into account that $p_i^* - p_j^* = \frac{1}{3}(2-\tau_1)(f_i - f_j)$ and performing some simple transformations, we obtain the following profit functions at the first stage of the game:

$$\pi_i(p_i^*, p_j^*) = \frac{\frac{1}{9}\left[(1-2\tau_1)f_i - (1+\tau_1)f_j + 3\tau_0\right]^2}{2\tau_0 - \tau_1(f_i + f_j)} - \delta f_i^2 \qquad i \neq j \qquad (12)$$

Indeed, the derivative of (12) with respect to airline's own frequency is a messy expression:

$$\frac{\partial \pi_i}{\partial f_i} = \frac{1}{9}\left[\frac{2(1-2\tau_1)\left(f_i(1-2\tau_1) - f_j(1+\tau_1) + 3\tau_0\right)\left(2\tau_0 - \tau_1(f_i + f_j)\right) + \tau_1\left[(1-2\tau_1)f_i - (1+\tau_1)f_j + 3\tau_0\right]^2}{\left(2\tau_0 - \tau_1(f_i + f_j)\right)^2}\right] - 2\delta f_i$$

However, symmetry of profit functions allows us to claim that in equilibrium both airlines will choose the same frequency (that is, $f_1^* = f_2^* = f^*$), and simplifies the first order condition for profit-maximization significantly to:

$$\frac{4-5\tau_1}{12} - 2\delta f^* = 0 \tag{13}$$

Note that the second-order condition for profit maximization is satisfied automatically. The equilibrium frequency obtains easily from (13) as:

$$f^* = \frac{1}{\delta}\left[\frac{4-5\tau_1}{24}\right] \tag{14}$$

Thus, other things equal, higher substitutability between carriers' services will induce the players to lower frequency in equilibrium. So, our model tells one to expect lower frequency of flights following a partnership that unites the carriers' frequent flier programs. Also, analysis of (14) shows that the above parameter restriction $\tau_1 < 0.8$ is necessary for equilibrium frequency to be positive. Finally, when $\tau_1 = 0$, we return to result of the baseline treatment in Hassin and Shy (2006).

The equilibrium price charged by the carriers is found by substituting (14) into (11), and is equal to:

$$p^* = \tau_0 - \frac{\tau_1}{6\delta} + \frac{5\tau_1^2}{24\delta} \tag{15}$$

We have previously said that a partnership between two airlines will manifest itself in an increase of the value of parameter τ_1. Here we see that impact of this parameter on equilibrium price depends on its value. It is, for example, easy to see that price will decrease with an increase in τ_1 as long as the value of this parameter is below 0.4; once we have reached this threshold, further increase in τ_1 will lead to increase in equilibrium price (until we have reached the value of 0.8 – assuming $\tau_0 > 0.8$). It is also true that $p^*(\tau_1 = 0.8) = \tau_0$; this implies that for any positive admissible values of τ_1 equilibrium price will be lower than that for $\tau_1 = 0$.

Next, let us see what happens to an individual airline's profit. An airline's profit function at the equilibrium values of frequency can be written as:

$$\pi^*(\tau_1) = \frac{1}{2}\left[\tau_0 - \tau_1\left(\frac{4-5\tau_1}{24\delta}\right)\right] - \frac{(4-5\tau_1)^2}{24^2\delta} \tag{16}$$

We have established admissible values of τ_1 to be between zero and 0.8. We have shown above that equilibrium price at the opposite ends of this interval is the same. This is, however, not true for the equilibrium profit. Observe that:

$$\begin{aligned} \pi^*(\tau_1 = 0) &= \frac{\tau_0}{2} - \frac{1}{36\delta} \\ \pi^*(\tau_1 = 0.8) &= \frac{\tau_0}{2} \end{aligned} \tag{17}$$

That is, value of the profit function at the highest admissible degree of substitutability is actually above that for $\tau_1 = 0$. Further analysis of (16) reveals that this function attains its minimum when $\tau_1 = \frac{4}{35}$; and $\pi^*\left(\tau_1 = \frac{8}{35}\right) = \pi^*(\tau_1 = 0)$. This means that, if before the partnership we had $\tau_1 = 0$, any increase in this parameter to the value of $\frac{8}{35}$ (approximately 0.22) or higher produced by such frequent flier programs cooperation will increase partner airlines' profit following the partnership. The mechanism behind this result is actually simple. Since higher substitutability reduces price and revenue (airlines share the market equally in equilibrium), players respond by reducing costs by reducing frequency of flights. Lowering frequency not only reduces cost, but also slows reduction in the revenue, since equilibrium price also depends on equilibrium frequency. Add to this decreasing returns to frequency (the model cannot be solved under constant returns assumption), and we will obtain faster reduction in costs than in revenue.

To complete the analysis, we need to examine what happens to consumer and total welfare on the market. Thanks to symmetry and uniform distribution of consumers, consumer welfare of those using airline 1 will be the same as for customers of airline 2. The total well-being of airline 1's passengers obtains as follows:

$$\begin{aligned} CS_1 &= \int_0^{0.5}\left(f^*(1+\tau_1 x) - \tau_0 x - p^*\right)dx = \int_0^{0.5}\left(f^*(1+\tau_1) - \tau_0 + x\left(f^*\tau_1 - \tau_0\right)\right)dx = \\ &= \frac{1}{2}\left(f^*(1+\tau_1) - \tau_0 + \frac{1}{4}\left(f^*\tau_1 - \tau_0\right)\right) = \frac{1}{2}\left(\frac{16-25\tau_1^2}{96\delta} - \frac{5\tau_0}{4}\right) \end{aligned} \tag{18}$$

That is, consumers become worse off as a result of higher substitutability between airlines. Strictly speaking, it's not the higher substitutability that hurts consumers (in fact, higher substitutability opens door to fiercer price competition, which should benefit consumers), but the way airlines respond to it. While more substitutability should increase consumer's utility, other things equal, reduction in equilibrium frequency (which is the carriers' response) is working to result in reduced consumers' well-being.

The total welfare (defined, as always, as the sum of all profits and consumer surpluses) will also fall for positive values of τ_1. To see this, observe the derivative of the total welfare function with respect to τ_1 is (the corresponding parts of the puzzle are (16) and (18)):

$$\frac{\partial TW}{\partial \tau_1} = \frac{70\tau_1 - 8}{24^2 \delta} - \frac{50\tau_1}{96\delta} = \frac{-8(1+10\tau_1)}{24^2 \delta} \tag{19}$$

Expression (19) clearly takes on negative values for positive values of τ_1.

3. Discussion and Concluding Comments

So, let us briefly discuss our results. The model presented in the previous section shows how airlines can potentially use parallel FFP partnership to increase their profit, even though no coordination between them is explicitly allowed and the carriers' services become more substitutable from the consumers' point of view. We also suggest that such a partnership does not benefit consumers, as one would suspect (higher substitutability generally means fiercer price competition). The result obtains because carriers react to lower revenue by cutting frequency of flights, which negatively affects consumers' utility. At the first glance, our result seems weird: equilibrium price following FFP partnership seems more likely to decrease than to increase[4], which should make consumers happier. Yet, lower frequency (a variable consumers care about) produces losses in consumer surplus.

It is interesting to note the difference between our result and the one due to Richard (2003). Richard considers a problem of (hypothetical) airline merger where consumers care about prices and frequency. The model he uses is totally different from ours, and Richard's results show that following a merger a new airline will set frequency at a higher level than any of individual competitors before the merger; as a result, impact of merger on consumer surplus is largely ambiguous as higher price and higher frequency

[4] Strictly speaking, direction of price change depends on how substitutable the carriers' services were before the partnership.

work in the opposite direction. While we do not analyze the possibility of a merger in our framework, it is possible that if airlines were allowed to act as a single entity, fall in frequency would not be observed. In our model, decrease in frequency is a way for carriers to offset negative (for their profits) effects of fiercer price competition due to higher substitutability – a problem monopolist would not face. This discussion raises another interesting question not addressed in this paper. If frequency choice is taken into account, will mergers necessarily be better for consumer surplus than parallel airline partnerships?

One can criticize our work because we do not allow for repeated purchases, whereas frequent flier programs are aimed at repeat customers. Also, as indicated in the introduction, we have not taken into account such features of FFP as increasing marginal value of FFP points/miles and non-linear structure of awards. However, we believe our model can be applied to analyzing FFP partnerships. First, value of a frequent flier program to consumers positively depends on the number of flights with which miles can be earned and redeemed (represented by frequency in our model). Second, FFP partnership increases this set of flights, and this is precisely what happens in our analysis. One can think about this model as a first approximation to reality, which actually yields rather interesting results.

Analysis of FFP partnership is actually a more complicated issue than it appears at the first sight. Airline consolidation takes on many different forms, and joint frequent flier programs is only a part of the airlines' strategy in this area. In fact, as shown by Lederman (2003) FFP partnerships on the US market are only 'half-parallel', since partner airlines' networks overlap on only about half of city-pair markets. Our model therefore considers only the parallel constituent of FFP partnerships, without taking into account possible effects on or from the non-overlapping portions of airlines' networks. We do, however, show that a strictly parallel FFP partnership may not be as harmful to the partners as suspected; as long as airlines have an instrument they can use to offset the negative effect of fiercer price competition, which is a natural result of higher substitutability (frequency serves as such a tool in our case). Actually, the fact that parallel FFP partnerships are usually bundled with other forms of airline consolidation – such as code-sharing agreements – makes empirical testing of our model a rather difficult task. Yet, we can suggest another dimension to analysis of airline partnerships on domestic US markets. So far, researchers considered price and consumer welfare effects of code-sharing agreements (Bamberger et al., 2004, Ito and Lee, 2005, Armantier and Richard, 2005, 2006), or effects of FFP partnerships on demand (Lederman, 2003, 2004, 2005). We suggest parallel FFP partnerships (rather typical for US market as opposed to international routes) can influence airlines' behavior. Moreover, carriers' response to increased substitutability of their services can eventually decrease consumers' surplus. While integrating joint frequent flier programs into analysis of domestic airline consolidation is outside of the scope of this paper, our results suggest it may be necessary to do so in future research and policy debates.

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