Breeding Incentive Programs and Demand for California Thoroughbred Racing: The Tradeoff Between Quantity and Quality

by

Martin D. Smith

Department of Agricultural and Resource Economics
University of California, Davis
Davis, CA 95616-8512
Phone: (530) 754-8172
Fax: (530) 752-5614
e-mail: smith@primal.ucdavis.edu

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Abstract: Both quantity of horses and quality stimulate demand for horse race gambling. This paper addresses the potential for a quantity/quality tradeoff due to breeding incentives for California thoroughbreds. Econometric analysis is used to assess the demand for quality and quantity of horses, and results suggest the likely net benefit of breeding incentives on the industry at large.

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The thoroughbred racing industry in California is currently embroiled in a policy debate about breeding incentive programs. Some parties think that special awards to breeders are **incentives** that improve the long-run health of the industry. Others see them as **subsidies** that undermine the quality of the breed and ultimately harm the industry at large. Industry officials agree that increased quality of thoroughbreds stimulates demand for the industry's end product, horse race gambling. It may not be obvious, however, that a higher quantity of horses may also stimulate the demand for horse race gambling. How do breeding incentives affect quality and quantity of Thoroughbred race horses? How do quantity and quality, in turn, affect demand for horse race gambling? This paper addresses these questions with an analytical model of breeder decisions and an econometric analysis of demand for Thoroughbred racing in California.

In recent years, interest has grown in agricultural economics about quality effects of agricultural policies that do not aim at changing product quality. For instance, subsidies and quotas aimed at transferring income to farmers may have the unintended consequence of altering product quality. Breeding incentives in the California Thoroughbred horse racing industry provide an interesting twist on this debate; though quantity and quality might both stimulate

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demand, the net effect of quantity at the expense of quality is unknown. This issue has not yet been addressed in the economics literature about horse rading. There are, however, numerous studies about horse racing that deal with similar issues. Articles that have focused on horse breeding are mainly hedonic analyses of pedigree characeristics such as Buzby and Jessup (1994) and Lansford, Jr., Freeman, Topliff, and Walker (1998). Kraft (1996) provides a dynamic analysis of breeding markets but does not consider breeding incentive policy variables. Church and Bohara (1992) study the regulatory environment of horse racing in New Mexico and find that too many racing days are granted for joint industry profit maximization, but the number of days is consistent with state revenue maximization. The most relevant topic in the literature is demand for parimutuel wagering, e.g. Thalheimer and Ali (1992,1995), Pescatrice (1980), Morgan and Vasche (1982), and Ali and Thalheimer (1997). This last paper finds a positive and statistically significant relationship between quality and wagering. Perhaps the most important policy-relevant finding of these studies is that demand for wagering with respect to a reduction in the takeout rate (i.e. the share of parimutuel handle that is not returned to the bettors) is elastic. Unlike these papers, my econometric analysis uses individual race data to estimate the effects of racing characteristics on handle. Previous studies that have looked at individual race betting activity have focused on market efficiency hypotheses and questions about risk preferences of bettors, e.g. Ali (1977, 1979) and Golec and Tamarkin (1998).

The breeder incentives program in California consists of four components: breeder awards, owner awards, stallion awards, and restricted purses. The first three provide funds in addition to the regular purse (award money for winning horses) to California breeders, owners of California-bred horses, and owners of California stallions. As such, breeders and stallion owners maintain an open interest in the offspring of their horses even if they do not own these offspring. California horse racing also provides incentives to owners of California-bred horses by creating restricted purse races in which only Cal-breds are eligible to run. Figure 1 reports the magnitude of each component of the program over time. To put these figures in context, purse awards in California during 1997 totaled $136 million and 1997 total parimutuel handle in California was roughly $3 billion. Revenues that support the breeding incentive program come from the parimutuel handle takeout. For 1998, the total takeout for conventional wagers was 15.63%, with 4.446% going to the State of California, 5.545% to the race tracks, 4.646% to stakes and purses, .365% to breeder incentive awards, .33% to local governments, and .1% to equine research. Thus, possible alternative uses of breeder incentives include quality enhancement through investment in breeding research, increasing purses for open company (i.e. non-restricted purse races), increasing state or race track revenues, or reducing the takeout rate.

The conceptual analysis of breeding incentives focuses on breeder and owner awards. Consider a breeder who owns a mare of given quality. The breeder must decide to breed or not, and if breed, what stallion quality. Actual quality of the offspring is a random variable (q). One can think of the stallion choice and the fixed mare quality as jointly generating the deterministic component of q, say $\overline{q}$. If a live foal is born, the breeder chooses to sell the foal as a yearling or keep the foal for racing. Finally, the owner chooses when to retire the horse (T).[1] Denote the discount factor as δ, profits as π, and the probability that a horse buyer races the horse in California as ϕ. $C(\overline{q})$ is the stud fee plus the fixed cost of horse care for first year, P(q) is the sale price of the yearling, NR(q,t) are racing revenues net of variable costs (as a function of time and quality), S(q,T) is the scrap value (breeding value at retirement), b(q,t) denotes breeder awards, and o(q,t) represent owner awards.

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[1] Of course, some horses may never make it to the race track. This does not modify the analysis because at the decision times, breeders and owners choose based on expectations of functions of the random variable q.

For a given foal, the breeder sells if $Ep|_{Sell} \geq Ep|_{Race}$. When there is no breeding incentives policies, this condition is:

$$P(q) \geq E\{\sum_{t=1}^{T}[d^t NR(q,t)] + d^T S(q,T)\} \tag{1}$$

Similarly, a buyer will purchase the yearling if $Ep|_{Race} \geq price$, or:

$$P(q) \leq E\{\sum_{t=1}^{T}[d^t NR(q,t)] + d^T S(q,T)\} \tag{2}$$

Assuming the same expectations and information, these two conditions imply that a sale will take place if and only if the sale price equals the discounted expected net racing returns plus the discounted expected scrap value. The breeder chooses to breed if $Ep|_{breed} \geq 0$, which implies:

$$d\,E\{\sum_{t=1}^{T}[d^t NR(q,t)] + d^T S(q,T)\} - C(\overline{q}) \geq 0 \tag{3}$$

Owner and breeder awards modify the decision rules. The breeder will sell if:

$$E\{f\sum_{t=1}^{T} d^t b(q,t)\} + P(q) \geq E\{\sum_{t=1}^{T} d^t [NR(q,t) + o(q,t) + b(q,t)] + d^T S(q,T)\} \tag{4}$$

The buyer is willing to purchase the horse if:

$$P(q) \leq E\{\sum_{t=1}^{T} d^t [NR(q,t) + o(q,t)] + d^T S(q,T)\} \tag{5}$$

If ϕ=1, then expected breeder awards cancel from both sides of (4), and (4) and (5) together give rise to a selling environment like in (1) and (2). For ϕ<1, however, sales would never take place because both inequalities (4) and (5) could never hold with positive breeder awards. Alteration of the breeding may also lead to thin markets for yearlings. The breeder will breed the horse if:

$$d\,E\{\sum_{t=1}^{T} d^{t}[NR(q,t)+o(q,t)+b(q,t)]+d^{T}S(q,T)\}-C(\overline{q})\geq 0 \qquad (6)$$

But, this implies that if expected breeder awards are large enough, some horses will be bred that will never be sold. To see this, consider the case where (6) holds but

$$E\{\sum_{t=1}^{T} d^{t}[NR(q,t)+o(q,t)]+d^{T}S(q,T)\}\leq 0 \qquad (7)$$

Clearly, given (7), no buyer would pay a positive price for the yearling. Thus, breeder awards may give rise to thin yearling markets. In contrast, owner awards do not distort yearling markets because expected value of the policy is capitalized fully into the sale price of the horse.[2]

Inequalities (1)-(7) not only question the viability of a yearling market with breeding incentives, but they also highlight the potential for breeding sub-marginal horses. Comparing (3) to (6), even in the absence of restricted purse races and stallion awards, some horses may be bred under an incentives program that would otherwise not be bred. This would suggest that quantity increases and average quality decreases. What these inequalities do not address is the potential for breeding incentives to draw breeding into the state of California. If horses are drawn into the state from elsewhere, quantity increases even more. The key unknowns are whether out-of-state horses drawn into California increases average quality, and if so, whether this increase is enough to offset quality declines due to sub-marginal in-state breeding.

Although the magnitudes of breeding incentive quality and quantity effects are empirical questions left unanswered, it is useful to analyze empirically how quality and quantity affect horse racing demand. Demand has two components: race track attendance and parimutuel handle (betting activity), the latter generating the lion's share of revenues. Attendance on a given day is a function of prices, income, advertising, and race characteristics for that day. Handle for a given race is a function of prices, income, attendance, and race characteristics. So the following equations describe the demand system:

$$A_t = f(P_t^A, P_t^H, P_t^O, I_t, ADV_t, \overline{\mathbf{Z}}_t) \tag{8}$$

$$H_{it} = g(P_t^H, P_t^O, I_t, A_t, \mathbf{Z}_{it}) \tag{9}$$

where A is attendance; H is handle; t indexes the day; i indexes the race; P^A, P^H, and P^O are prices of attendance, handle, and other goods; I is income; ADV is advertising; and **Z** is a vector of race characteristics.[3] Note that all prices are exogenous, and the demand system is recursive.

The data set contains attendance, handle, and race characteristics for all races run in California during 1997 and 1998.[4] Race days are allocated such that on any given day there is never more than one major track racing in Northern California and one in Southern California. Thus, in Southern California, it will be Del Mar, Hollywood Park, or Santa Anita. In Northern California, the major track will be either Golden Gate or Bay Meadows. Racing at state fairs takes place between major race track meets and only overlaps some with other fair meets at any given time.[5] "On-track" attendance (ONATT) is attendance at the actual live racing. "Off-track" (OFFATT) is total attendance at other race tracks and satellite wagering facilities in the same geographical region as the track with live racing. Total handle (REGHANDL) is the sum of on-track and off-track handle at tracks in the same region. As an illustrative example, off-track attendance and handle at Del Mar, which is in Southern California,

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[2] It is worth noting that Kentucky, which has the most prosperous breeding industry and yearling market in the country, has large owner awards but very limited breeder awards.
[3] Note that the vector of characteristics that affects attendance is a summary of all of the races that day.
[4] Due to some missing attendance figures, about 15% of the observations are excluded from the regression analyses.
[5] The fair meets that overlap take place in Fresno and Humboldt, both of which are geographically isolated from other Northern and Southern California racing facilities.

include attendance and handle on Del Mar races at Santa Anita and Hollywood Park but does not include attendance and handle on Del Mar races at Golden Gate or Bay Meadows.

Because prices, income, and advertising largely do not vary within a season at a particular race track, demand analysis of attendance and handle admits a hedonic specification. Fixed effects (i.e. race track/season dummy variables) capture differences across race tracks and years in admission prices, advertising campaigns, and incomes of the local populations. The takeout rate between 1997 and 1998 did not change.[6] This leaves a rich set of regressors to explain attendance and handle. PURSE is the award money that is distributed to owners of the top finishers in a race. It is both a policy variable and a proxy for quality (i.e. higher purses, *ceteris paribus*, attract better horses). As an indicator of quality, the coefficient on purse in attendance and handle regression should be positive if racing fans demand quality. RUNNERS indicates the number of horses in the betting event. This is a measure of quantity of horses, so the expected coefficient is positive if bettors really do prefer more horses to less in a betting event. CAL-BRED is a dummy variable for whether the race is a restricted purse for California-bred horses only. If Cal-breds are of lower quality on average, I expect this variable to be negative. SPRINT, CLAIM, DIRT, MAID, STAKE, WEEKEND, and LAST are all dummy variables as well. SPRINT indicates a race less than one mile, CLAIM indicates a claiming race (generally a lower quality race), DIRT indicates a race on dirt (as opposed to turf or grass), MAID stands for maiden race (a race restricted to non-winners), STAKE is a stake race (generally a high quality race), WEEKEND indicates the race day is Saturday or Sunday, and LAST denotes the last race of the day. Averages of

[6] Technically, there is a different takeout rate for conventional (Win, Place, and Show) and exotic (e.g. exacta, trifecta) wagering. As such, the aggregate takeout rate is endogenous. The race-by-race data, unfortunately, do not break down handle between conventional and exotic wagers. To get around this problem, one can think of conventional and exotic wagers as different goods with different prices, but the relative prices remain constant over the sample period.

RUNNERS, CAL-BRED, SPRINT, CLAIM, DIRT, MAID, STAKE, and WEEKEND appear in the attendance regressions along with a variable for number of races (RACES) and an additional dummy, (FRIDAY).

Table 1 reports results from on and off track attendance regressions (using ordinary least squares). The adjusted R-squared values of .72 and .81 are extremely high considering the amount of variation in attendance within race track seasons. Positive and significant coefficients on AVPURSE and SSTAKE as well as the negative and significant coefficients on SCLAIM and SMAID (in the on track regression only) suggest that racing fans demand quality. RACES is negative in both regressions and significant at the 10% level in the off track attendance. Though this appears strange, it may be due to multicollinearity involving the weekend variable and the fixed effects for fair racing, since more races are offered on weekends at some race tracks and typically fair racing offers more events but is lower quality. The number of horses running (AVRUN) does not have a statistically significant effect on attendance.

Table 2 reports the OLS handle regression results. Again, the adjusted R-square of .81 is extremely high; race and race day characteristics explain most of the variation in wagering activity. On and off track attendance as well as number of runners in a race are all important determinants of handle. The positive and significant PURSE variable along with the negative and significant CAL-BRED, CLAIM, and MAID variables all highlight the importance of quality in handle demand. Curiously, the STAKE variable is negative (but not significant). This is likely due to multicollinearity problems with other variables involving quality (particularly PURSE). One further note about this regression is that

LAST is positive, significant, and quite large in magnitude.[7] For losers on the day, this may reflect a last desperate attempt to recover losses. For winners, on the other hand, this effect may reflect risk-taking with transitory income, namely the day's winnings.

I also calculated elasticities for variables that are significant at the 5% level. Elasticities include both direct and indirect effects if the variables are significant in the attendance regressions as well. So, for instance, the elasticity of handle with respect to purse is:

$$e_{handle,\,purse} = \{\frac{\partial H}{\partial Purse} + \frac{\partial A_{on}}{\partial Purse}\frac{\partial H}{\partial A_{on}} + \frac{\partial A_{off}}{\partial Purse}\frac{\partial H}{\partial A_{off}}\}\frac{\overline{Purse}}{\overline{H}} \qquad (10)$$

The purse elasticity of handle is highly inelastic. Given that previous studies have found elastic demands with respect to takeout, adding to purse size to increase handle is not sensible in isolation. However, the effect of purse increases on attendance revenues, the ability to draw quality horses, and an increased quantity of entrants are potential justifications for this policy. In contrast to the highly inelastic purse elasticity of handle, the number of runners elasticity of handle is only slightly inelastic.

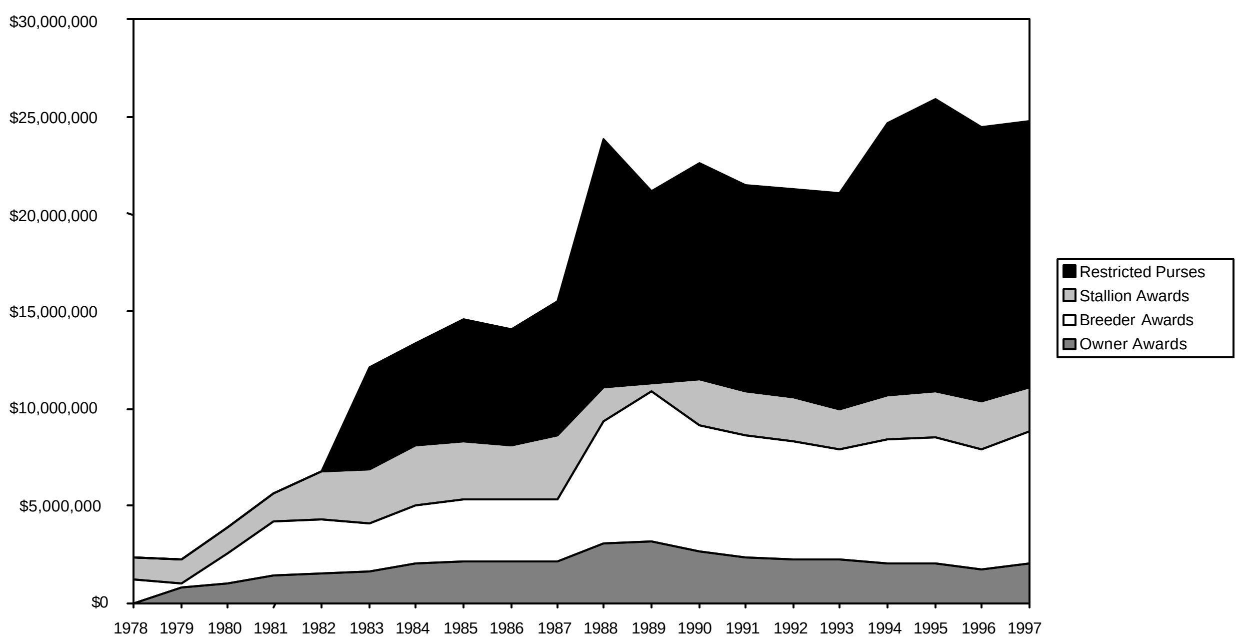
There is some evidence that breeding incentives successfully generate quantity, but the net effect on handle demand appears negative. The average number of runners for Cal-bred races was 9.2 and 8.7 in 1997 and 1998 respectively, compared to averages for non-Cal-bred races of 7.9 and 7.6. These numbers also suggest a downward trend in number of runners industry-wide. By applying the regression coefficients on RUNNERS and CAL-BRED only, the handle increase from .5 extra runners in 1997 is more than offset by the decrease from being a Cal-bred race (.5*25392-17351 = -4655). With only .3 extra runners in 1998, the net effect is even more negative.

[7] If only the track could have more than one last race each day!

Empirical analysis of demand for horse racing highlights the potential tradeoff between quality and quantity of horses. Conventional wisdom suggests that, *ceteris paribus*, racing fans prefer higher quality races. This assertion is supported by statistical evidence of higher attendance levels on days with high grade stakes races and more parimutuel handle on better races. Most racing fans would also indicate that they prefer races with more horses in them, e.g. a twelve horse field, *ceteris paribus*, is preferred to a five horse field. This assertion is also supported by statistical evidence, though quantity appears to affect handle only (not attendance). A plausible explanation is that more horses in a field on average improve the quality of a race as a betting event. The net effect of breeding incentive programs

Figure 1

California Breeding Incentive Awards



is difficult to assess. If more runners are produced for a low cost, it may be worth potential quality slippage.

Table 1

Fixed Effects Attendance Regressions

Variable	On Track Coefficient	St. Error	t-statistic	P-value	Off Track Coefficient	St. Error	t-statistic	P-value
RACES	-148.99	121.55	-1.23	0.221	-144.54	80.54	-1.80	0.073
AVPURSE	0.06	0.01	6.87	0.000	0.04	0.01	6.23	0.000
AVRUN	201.16	145.23	1.39	0.166	-82.25	96.23	-0.86	0.393
SDIRT	-860.13	1,112.52	-0.77	0.440	-609.02	737.16	-0.83	0.409
SMAID	-1,958.51	912.14	-2.15	0.032	35.69	604.38	0.06	0.953
SCAL	-1,208.46	1,025.16	-1.18	0.239	-237.19	679.27	-0.35	0.727
SCLAIM	-4,401.92	892.24	-4.93	0.000	-2,488.13	591.20	-4.21	0.000
SSTAKE	16,316.00	1,858.54	8.78	0.000	5,601.95	1,231.46	4.55	0.000
D97NF	6,656.91	1,880.98	3.54	0.000	9,128.70	1,246.33	7.32	0.000
D98NF	7,152.78	1,865.02	3.84	0.000	8,848.07	1,235.75	7.16	0.000
D97DM	13,327.00	1,864.45	7.15	0.000	16,741.00	1,235.38	13.55	0.000
D98DM	12,920.00	1,839.13	7.03	0.000	15,758.00	1,218.60	12.93	0.000
D97FP	5,188.43	2,134.74	2.43	0.015	10,729.00	1,414.47	7.59	0.000
D98FP	4,879.45	2,113.13	2.31	0.021	12,013.00	1,400.15	8.58	0.000
D97OT	10,299.00	1,874.32	5.50	0.000	12,435.00	1,241.92	10.01	0.000
D98OT	11,618.00	1,855.75	6.26	0.000	12,757.00	1,229.62	10.38	0.000
D97SA	10,765.00	1,845.87	5.83	0.000	14,474.00	1,223.07	11.83	0.000
D97HS	9,780.82	1,803.26	5.42	0.000	14,527.00	1,194.83	12.16	0.000
D97HF	7,020.32	1,787.66	3.93	0.000	11,540.00	1,184.50	9.74	0.000
D98HF	6,571.36	1,760.32	3.73	0.000	11,276.00	1,166.38	9.67	0.000
D97BM	6,405.06	1,807.87	3.54	0.000	7,386.79	1,197.89	6.17	0.000
D98BM	6,502.13	1,831.42	3.55	0.000	7,410.50	1,213.49	6.11	0.000
D97GG	5,575.50	1,853.13	3.01	0.003	8,154.41	1,227.88	6.64	0.000
D98GG	5,448.28	1,826.94	2.98	0.003	7,865.56	1,210.53	6.50	0.000
WEEKEND	2,035.97	293.79	6.93	0.000	2,791.91	194.67	14.34	0.000
FRIDAY	1,479.85	276.91	5.34	0.000	681.28	183.48	3.71	0.000
Observations	1,004				1,004			
Adj. R-squared	0.7155				0.8143			
Mean of Dependent Variable	6,749				8,464			

Note: Constant was dropped to include all track/season dummies.

Table 2

Fixed Effects Parimutuel Handle Regression

Variable	Coefficient	Std. Error	t-statistic	P-value	X-bar	Elasticity
ON ATT	7.82	0.35	22.39	0.000	6,749.10	0.1967
OFF ATT	11.18	0.57	19.71	0.000	8,464.01	0.3524
PURSE	0.41	0.03	12.44	0.000	29,042.11	0.0558
RUNNERS	25,392.00	610.06	41.62	0.000	7.92	0.7495
CAL-BRED	-17,351.00	3,632.43	-4.78	0.000	0.11	-0.0076
SPRINT	1,807.24	2,353.58	0.77	0.443	0.61	
CLAIM	-18,749.00	2,664.11	-7.04	0.000	0.68	-0.0661
DIRT	-4,273.18	3,665.79	-1.17	0.244	0.86	
MAID	-10,916.00	2,432.14	-4.49	0.000	0.29	-0.0051
STAKE	-2,849.96	5,969.29	-0.48	0.633	0.05	
WEEKEND	1,493.68	2,653.60	0.56	0.574	0.18	
LAST	166,365.00	3,336.57	49.86	0.000	0.12	0.0732
D97NF	-220,239.00	7,370.93	-29.88	0.000		
D98NF	-214,429.00	7,205.06	-29.76	0.000		
D97DM	14,289.00	10,194.49	1.40	0.161		
D98DM	19,809.00	9,882.62	2.00	0.045		
D97FP	-148,683.00	9,967.41	-14.92	0.000		
D98FP	-132,954.00	10,289.47	-12.92	0.000		
D97OT	-60,400.00	9,823.20	-6.15	0.000		
D98OT	-74,951.00	9,503.68	-7.89	0.000		
D97SA	1,050.10	8,968.26	0.12	0.907		
D97HS	-28,702.00	9,017.46	-3.18	0.002		
D97HF	-60,906.00	8,825.40	-6.90	0.000		
D98HF	-57,374.00	9,100.91	-6.30	0.000		
D97BM	-168,622.00	6,579.76	-25.63	0.000		
D98BM	-165,952.00	6,453.86	-25.71	0.000		
D97GG	-166,569.00	6,895.51	-24.16	0.000		
D98GG	-166,021.00	6,764.43	-24.54	0.000		
Observations	8,560					
Adj. R-squared	0.8121					
Mean of Dependent Variable	268,430					

Notes:
Constant was dropped to include all track/season dummies.
Mean of ONATT and OFFATT differ from attendance regression dependent variable means because here they are race weighted averages.
Elasticities are calculated if the variable is significant at the 5% level in the handle regression.
Elasticities include both direct and indirect effects if the variables are significant in the attendance regressions.

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