# MARKET ENFORCED INFORMATION ASYMMETRY: A STUDY OF CLAIMING RACES

CHRISTOPHER D. HALL*

*This is a study of complementary markets. The race track polices the betting market with information revealed in a 'claiming horse' market. This policing reduces the adverse consequences of asymmetric information: experts in identifying horses and fraud are deterred from biasing betting odds against bettors at large. Consequently, bettors specialize in evaluating published race information. This 'monitoring' theory is compared to a competing theory of claim races as a self-assessed horse market. Parametric data is used to evaluate each theory. Institutional details also provide a test of each theory.*

## I. INTRODUCTION

The gains from trade may be limited by the extent of asymmetric information. In insurance markets, for example, the well-informed, accident-prone individual will wish to carry insurance. If the company does not identify and price this added risk, the premiums charged to all insurants may increase to such an extent that the market 'fails' to insure lower risk people.[1] An asymmetric distribution of information between well-informed, high-risk insurants and less well-informed insurers may cause the low risk, low premium, insurance market to fail.

Not included in most analyses of asymmetric information are specific institutional details which may act to reduce the costs associated with asymmetric information. Scrutiny of such details may reveal why, despite the threat of market failure, differences in expertise characterize all markets. The observed disparity of information is not merely a result of an assumption about its initial distribution. It must also be the consequence of a process that *preserves* informational asymmetries and, at the same time, provides sufficient incentives for markets to operate.[2]

*University of Hong Kong and Simon Fraser University. Steve Easton provided many valuable comments, as did an anonymous referee. Thanks are also extended to Yoram Barzel, Kelly Busche, John Chant, Steven Cheung, Harold Demsetz, Elizabeth Granitz, Denise Martin, Clyde Reed, and to Donna Wilson for their comments.

1. The literature dealing with asymmetric information is vast. I include only a few representative citations to illustrate the diversity of application. See: Akerlof (1976), Eaton and White (1982), Grossman and Stiglitz (1980), Hashimoto and Yu (1975), Jordan and Radner (1982), Rothschild and Stiglitz (1976), and Vickrey (1961).

2. Brand names, specific investments, and bonding in general have been argued to be means by which specialization and thus asymmetric information becomes profitable. As examples see: Becker and Stigler (1974), Darby and Karni (1973), Klein and Leffler (1981), and Williamson (1982). Barzel (1981) shows how tying arrangements reduce the problem of asymmetric information.



Economic Inquiry
Vol. XXIV, April 1986

If information is required for a market to operate, and specialization in its production is efficient, there must also be a mechanism which restrains the use of differential expertise to transfer wealth from the less informed to experts. In this setting, asymmetric information is endogenous: it is the outcome of a market structure which both rewards research and reduces the adverse consequences of asymmetric information sufficiently to prevent market failure.

This paper uses this theory to interpret the 'claim horse' market as an instrument which encourages the exchange of horse race wagers. It is argued that the 'claim horse' market is subsidized by the track in order to increase revenue derived from betting and that information produced for the claim market is used to police the betting market and to advertise the honesty of races.

First, the paper describes some incentives to bias betting odds and the advantage of experts in discovering a bias. The 'monitoring' theory of the claim horse market is then developed to explain how experts are paid to research the extent of fraud, to reveal their findings to the track, and to advertise the honesty of races by purchasing horses.

A competing explanation of the claim market as a 'horse market' is explored next. This interpretation shares some implications with the monitoring theory, but differences are also found and used to test their relative explanatory power.

The institutional details of claiming are used to test the theories. The monitoring theory better explains the details, but the horse market is consistent with some of the rules.

Finally, traditional hypothesis tests are conducted with data including variations in the numbers of horses purchased in the claim market. Again, the monitoring theory provides a better explanation of these data.

## II. THE CLAIM RULE AND THE PURSE

In some seventy-five percent of all horse races in North America there is a claim rule. The claim rule requires, as a condition of entering the race, that every horse is committed to be sold at a price stipulated and advertised by the track.[3] For example, if the claim price for horses in a given race is set at $10,000 and an eligible claimer wants a specific horse, that animal must be sold at $10,000.

The track does not own or buy horses, nor does it assign horses to races. The track only sets the claim price and assures that, if claimed, the horse is sold at the claim price. All claims are made prior to the start of the race, and the track does not reveal which, if any, horses have been purchased until after the finish.[4]

3. This is a simplification. In some races there are two or more claim prices available to owners, as explained later.

4. The mechanism by which horses are directed to races is not analyzed here.

The other major parameter set by the track is the purse, or prize money. This money is provided by the track in all claiming races and is divided in fixed proportions among the owners of the top five horses.[5] Nothing prevents an owner from betting on the race in which his horse is running. It is, however, important to note that prize money and betting revenue are separate rewards for separate activities.

A crucial feature of the claim rule is that only the horse is claimed, not the prize money. Because the purse belongs exclusively to the owner at the time of entry, the track can entice horses worth more than the claim price into a race. To paraphrase the Law of Demand—for a sufficiently high prize, each owner is willing to risk losing his horse to a claimer.

In conjunction with the purse, the claim rule is used to reward experts for performing two functions. First, experts police the list of race contestants to discourage horse switching and related fraud. Second, they advertise the honesty of races to bettors by claiming horses. The elegance of the system lies in its ability to reveal information obtained by experts whether or not they act on it directly.

## III. FRAUD AND THE OBJECTIVE OF THE TRACK: THE CLAIMING SIGNAL

Horse owners and trainers know more about their horses than bettors at large. To encourage betting, it is essential that no significant information bias exist. Were owners and trainers to win persistently, *i.e.*, were information to be distorted routinely, horse racing betting would not enjoy its observed popularity.[6]

Betting is asserted to be a market for disagreement over winning probabilities: wagers are placed when the pari-mutuel odds diverge from a bettor's expectations. Since the purpose of fraud is to transfer wealth from bettors, its effect is to reduce willingness to bet. The track responds directly to the threat of fraud by policing races and indirectly by using the claiming market.

The track's revenues are derived as a fixed proportion of the betting volume. This volume increases with the quality (price) of competitors in honest races. It is maximized subject to the usual expenses, which include the prize money and the costs of policing and advertising the honesty of races.

Many types of fraud are possible, including drugging horses, switching horses, and collusion between jockeys. The claiming rule seems most directly related to horse switching, but other fraudulent activities may be dis-

5. The track studied in the empirical section, Longacres, near Seattle, Washington, divides the purse between the first five finishers as: 55, 19, 14.5, 9, and 2.5 percent, in order. Winning jockeys receive a fee equal to 10 percent of the purse while the others receive a fixed amount. In a race with $P = \$10{,}000$, for example, the winner gets \$1,000, the second gets \$75, the third receives \$60, and the rest are paid \$45 each.

6. Horse racing ranks as the most popular spectator sport, after college football.

couraged by claiming simply because more people watch and inspect the horses entered in claiming races in the hope of finding a bargain. Although fraud is monitored in several ways, this paper focuses on the role played by potential claimers in policing the entry list itself.

The basic argument is that when the track offers sufficiently large prizes, owners willingly enter horses worth more than the claim price. In anticipation of finding bargain horses, claimers collect information on horse prices and qualities. This search substitutes for other policing expenses and compensates the track for the added prize money it offers to induce entries. The search, however, does not automatically benefit the track because the track and horse experts have different incentives to report fraud.

The most important discoveries made by horse experts may be signaled by the absence of claiming. If the track notices a lack of claiming in spite of higher purses, resources may be directed to investigating this group of horses. The *threat* produced by this reallocation of policing resources discourages fraud.

There are two incentives to switch horses. Successfully switching a cheaper horse for the listed animal raises the winning probabilities relative to betting odds for the other horses. Switching to a faster horse has the opposite effect. The importance of each type of a switch depends on the distribution of betting odds. When the betting odds are about equal for each horse, it pays to switch to a better horse, and the opposite holds true when there is a heavy favorite.[7]

Claiming by itself may not discourage either type of switch. When a potential claimer discovers that a lower quality horse has been entered in place of the listed animal, he has no incentive to buy, nor to report the information. Even when a better horse is switched for a slower animal, there may still be no incentive to claim it. A claimer must be able to document the true identity of the animal to meet the legal requirements of entering the horse in subsequent races or when selling it. The claimer who does not spend the resources to redocument the horse may himself become the subject of an investigation if the switch is eventually revealed. The suspension or cancellation of racing privileges during an investigation is costly, even if the buyer is eventually found to be innocent.

Those contemplating fraud surely expect the extra costs of claiming a switched horse to deter potential claimers. A dishonest owner who anticipates this will not be discouraged by potential claimers as such.[8] Rather, it is the track's ability to interpret the absence of claiming that keeps the race honest.

When the purse and claiming price combination stimulate claiming, the new owners provide a signal to all observers, including bettors, that the

7. If both winning and losing pools were offered, the two incentives would be identical.

8. At a sufficient price differential, it will pay to claim despite these costs. However, this threat discourages entering such an expensive horse.

horses are as listed: claims advertise honesty. In the absence of (predicted) claiming, other policing methods will be used. Therefore, the threat produced by claiming, combined with complementary policing, reduces fraud.[9] To use a statistical analogy, the track looks at the residual of their estimation for the number of horses claimed in each race. Larger negative deviations signal increased probabilities of fraud. Most important, the availability of this signal acts to deter fraud, thus making bargain horses available to reward search, and to signal bettors that policing is effective.

## IV. THE BASIC MODEL OF CLAIMING GIVEN A PERFECTLY ELASTIC SUPPLY OF EQUALLY PROBABLE WINNERS

This section develops the basic model of claiming. The track sets the claiming rule and the purse-claim price combination to determine the maximum horse price in each race. Competition among horse owners then acts to determine the market prices of horses in each race. When market prices surpass claim prices, experts are rewarded by claiming bargain horses, and the race is advertised as honest.

Throughout the analysis the track is assumed to set entry conditions consistent with horse owners earning competitive returns. This is equivalent to assuming that (1) the supply of horses available for each type of race is perfectly elastic. It is also assumed that (2) only the winner earns a share of the purse, (3) that the average speed and horse market prices are perfectly correlated and constant over time, (4) that there are the same number of horses in each race, (5) that horse price information is free, and (6) that each horse in a race is equally likely to win. The first four assumptions are maintained throughout for the sake of simplicity.[10]

To illustrate the nature of the entry decision, consider a race in which the owner anticipates that his horse will be claimed. Suppose also that the market price, $M$, of this horse is just equal to the claim price set by the track, $C$. Given assumption 3, the outcome of the race does not affect $M$ since the winning probability, $b$, is already capitalized in $M$. Further, assumption 4 implies that $b = 1/N$ where $N$ is the number of horses entered.

The horse will not be entered if the owner's expected value of the purse is less than the (expected) value of alternative races. If $P$ is the purse offered by the track, the expected value of the purse, $bP$, must equal or exceed the costs, $aM$, plus the lost difference between market and claim prices, $M-C$.

For simplicity, costs are assumed to be a constant fraction, $a$, of $M$. This

9. Most thoroughbred race tracks pay the Thoroughbred Racing Protective Bureau a fee for policing based on the dollar volume of betting. They also employ their own police and utilize rules requiring registration and documentation of all thoroughbreds competing, or whose offspring will ever compete, in the U.S. These rules, for example, require that the inside of the lip of every thoroughbred be tattooed with a registered I.D. number.

10. In Hall (1982) the effect of cost differences between horses is explained. The individual maximizing decisions underlying this schedule are more eloquently and thoroughly explained in E.P. Lazear and S. Rosen (1981).

assumption embodies two factual considerations. First, horses require some time following a race to regain their strength, and consequently potential purses are sacrificed during this period. Second, higher priced horses generally compete for higher purses. This latter fact seems to reflect the betting public's propensity to bet more on better horses.[11] Implications of assuming $a$ to be constant and the same for all types of horses are explored later.

When the owner anticipates a claim, the most valuable horse willingly entered is given by

$$bP = M - C + aM, \quad \text{or} \tag{1}$$

$$M = P/N\,(1 + a) + C/(1 + a), \quad \text{for } M > C. \tag{1'}$$

Expected winnings equal the difference between market and claim prices, plus the costs of running.

If the race is one where a claim is not anticipated, the most valuable horse entered is given by

$$M = bP/a, \quad \text{for } M < C. \tag{2}$$

Equations (1′) and (2) may be viewed as functions showing the maximum horse price found in any race. When the track offers prize money and sets claim prices such that $M = C$, claimers are indifferent between buying or not buying. When $M = C$, $P/N = aM = aC$, or $P/C = aN$. This ratio, $P/C$, determines the point in Figure 1 where the maximum horse price function's slope becomes discontinuous. Assuming that price information is costless, horses will be claimed to the right of $P/C = aN$.

Schedule $MM$ becomes the equilibrium horse price function by incorporating assumptions (1) and (4), *i.e.*, a perfectly elastic supply of horses of each type and a fixed number of contestants. When horse prices fall below $MM$, the expected purse exceeds costs plus the difference between claim and market prices, and positive profits are captured by owners. Competition, however, eliminates these opportunities.[12] Thus, although the algebraic slope of $MM$ is determined solely by costs, competition is necessary to interpret $MM$ as the schedule of observed horse prices. Costs determine the maximum increase in horse prices. Competition insures that prices rise by no less than this amount.

The intersection of $MM$ with $C$ represents a possible 'target' for the track. If $P/C$ exceeds $aN$, and horse price information is free, positive profits will be captured by claiming a horse. However, if price information is free, there would be no reason for the track to subsidize claimers by adding money to the purse, thereby stimulating claims. The possibility that the track's target is a $P/C$ level consistent with no claims is explored later in the context of the competing theory of claim races.

11. Since betting volume increases with horse quality, track revenues increase with the purse.

12. It is assumed that all forms of rationing places in the race by queuing are eliminated by the track.

## V. INFORMATION COSTS AND THE PROBABILITY OF A CLAIM

Relaxing the assumption of costless price information, while maintaining the assumption of perfectly elastic supply, changes the analysis only slightly. The incorporation of information costs and an infinite supply elasticity may seem incongruous. The track has, however, two devices which facilitate the (self) assignment of horses to races by owners.

Two additional races are offered on each race day as possible substitutes for any of the ten primary races. If too few horses are entered in the primary races, one or both of the substitute races will be added in their place. These alternative races reduce the probability of selecting entrance rules which severely limit the potential supply of competitors. Opportunities for horse owners to capture above average returns are curtailed.

Owners are also permitted to 'scratch' horses, or take them out of the contest. If enough horses enter a race so that the net expected purse is negative, some will be withdrawn until zero profits are again expected. In other words, both provisions reduce the costs of mistaken information: neither the track nor owners need to be perfectly informed about the stock of potential competitors to avoid races in which negative (positive) profits are implied.

If information costs are important to owners and claimers, because each must judge the probability of a mistake and its consequences in deciding which race to enter or which horse to claim, claiming may be viewed as a bet of $C$ dollars that the claimer's information is accurate. Essentially, this means that the probability of a claim should increase with the difference between $M$ and $C$ per dollar wagered, *i.e.*, $(M-C)/C$.

If mistakes arise because the market price is ambiguous, and owners and claimers are risk neutral, the probability of a claim is given by the function $G$ as

$$\text{(3A)} \qquad \Pr(\text{claim}) = G\{(M + U - C)/C\},$$

where $U$ is a random variable distributed with mean zero and variance $V$, to describe the distribution of errors in determining $M$.

Assuming zero profits and equal winning probabilities (3A) becomes

$$\text{(3B)} \qquad \Pr(\text{claim}) = G\{[(P/N) - aC + U(1 + a)]/C(1 + a)\},$$

when a claim is anticipated by the owner.

For simplicity assume that the probability of a claim in the region of interest is a linear function. If $G = c_0 + c_1(M-C)/C$ where $c_1 > 0$, then (4) gives the number of claims conditional on $P$,$C$, and $N$:

$$\text{(4)} \qquad NG = [c_0 - ac_1/(1 + a)]N + c_1/(1 + a)(P/C) + (c_1N/C)U.$$

When the owner does not anticipate a claim, the number of claims becomes

$$\text{(5)} \qquad NG = (c_0 - c_1)N + [c_1/a)](P/C) + (c_1N/C)U.$$

Expressions (4) and (5) show the number claimed as a linear combination

of $P/C$ and $N$. The expected number of claimed horses increases with $P/C$ but not necessarily with $N$, and differs from the previous analysis in the impossibility of signing the effect of $N$ because $c_0$ may be less than $ac_1/(1+a)$, and in the error structure. In all cases the number of claimed horses rises as $P$ becomes large relative to $C$.

## VI. THE PAYMENT FOR RESEARCH

It is crucial to remember that each point along $MM$ describes a different equilibrium quality of (identical) competitors. Therefore, the vertical distance between $MM$ and $C$ to the right of $aN$ measures the maximum price the track could set for the right to buy a horse in the claim market.

The framework within which to contrast the 'horse market' and 'monitoring theories is established by the fact that the track does not charge claimers a fee, which implies a loss in revenue to the track and a gain to claimers. In the horse market theory, the track attempts to set $P/C = aN$, thereby minimizing the prize money spent for a given quality of horses and a given betting volume. Deviations in the number claimed from a constant target level result from random errors in estimating $N$ for a given $P$ and $C$ and because owners and claimers make mistakes in judging market prices.

In the maintained 'monitoring' theory, the attention of horse experts is directed to any desired quality of horses by increasing $P/C$. Assuming that the track either randomly searches for indications of fraud, or that different amounts of information are sought in each race, bargains are more likely to be found in races when $P/C$ rises. Individuals sufficiently expert to find these bargain horses are paid, indirectly, by the track's offering of higher purses.

The monitoring and horse market theories are both reexamined in the next section where the basic model is expanded by relaxing the assumption of equally probable winners. This analysis reveals another implication of the monitoring theory, one which is shared by the horse market theory: better horses will be claimed. The analysis also reveals an alternative target for the horse market theory: that the track will set $P$ and $C$ to limit the quality of the favorite horse.

## VII. THE EFFECTS OF UNEQUAL ODDS

Odds in horse races are rarely equal. Since average speed and market price are correlated, while the claiming price is the same for each horse, favored horses tend to be claimed. This characteristic of claiming races refines the signal in the sense that the odds tells us *which* horses should be claimed whereas the $P/C$ ratio only tells us when *some* horses should be claimed.[13] While this analysis does not explain the distribution of winning probabilities in a race, it does explain the effect of odds on claims.

13. The odds distribution is not explained by the monitoring theory. I assume it to be a random variable with variance sufficiently small to ignore the possibility that the distribution is truncated at $M = (P+c)/(1+a)$, *i.e.*, the price of a horse which is certain to win.

The market price of an average horse is found along $MM$ in Figure 1 because $b = 1/N$. If the market price of the favorite equals or lies below $C$, the differential of equation (2) may be used to find the price of a favorite. This superior horse's price lies above $MM$ by $\Delta M = (P/a)\Delta b$, where the difference between the favorite's winning probability, $b_f$, and $1/N$, the average probability, is $\Delta b$. If the average horse's price exceeds $C$, $\Delta M = P/(1 + a)\Delta b$, but since, in the sample, the largest number of horses claimed is four in any one race, only $P/C$ ratios less than $aN$ are of practical interest. The central, if obvious, point is that since the favorite's market price is the highest, it also stands the greatest chance of exceeding $C$.

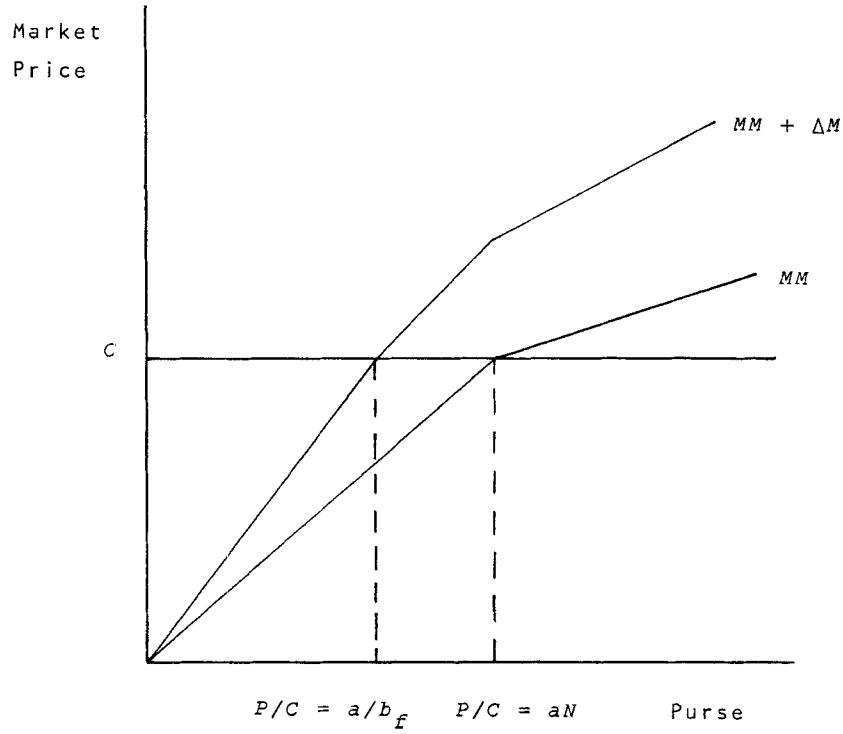


**FIGURE 1**
Price of the Average Horse and a Favorite Under Competition

In the preceding section, the intersection of $MM$ and $C$ was considered as a 'target' for the horse market theory because the track's intention is to minimize expenditures on the purse for a given betting volume, rather than to create bargains for claimers. With unequal odds, this target is likely to be the favorite instead of the average horse. For a given odds spread, say $\Delta b$, it may 'target' $P/C$ such that $MM + \Delta M$ equals $C$. For a given $\Delta b$, $M + \Delta M = C$ when $P/C = ab_f$, which is less than the target $P/C$ of $aN$ since $b_f$ exceeds $1/N$.

In a following section the use of the claim price to limit the quality of

horses will be discussed again. First, however, a further implication of the claim rule is examined.

## VIII. MORAL HAZARD

In anticipation of a claim, owners will instruct the jockey to ride faster or to take more risks to capture a share of the purse. This strategy increases the chance of winning; any damage done to the horse is born by the claimer.

Keeping the claim a secret does nothing to reduce the incentive to over-ride. The uncertainty of a claim reduces incentives to over-ride a horse which has actually been claimed, but this is offset by over-riding of horses that are mistakenly expected to be claimed.[14]

Moral hazard is inherent in the 'monitoring' interpretation since the track will at times encourage claiming to reward the research necessary for policing. The rule which prevents claimers from also taking the prize money would not be necessary if claiming were designed for purposes other than monitoring. The possibility of designing alternative claiming rules plays a central role in comparing alternative theories of claiming races.

## IX. A COMPETING THEORY OF CLAIMING RACES

There are many alternative interpretations of the claim price. Perhaps the most likely is that the claim market is primarily a self-assessed horse market. Claiming prices are self-assessed in that the claim price varies between races and the owner make the decision to enter or not.

The pooling of horse price information by the track may reduce the costs to owners of evaluating the quality of competitors and deciding which races to enter. By reducing the owners' costs, the track will be able to offer reduced purses for the same quality of horses.

The clearest benefit of a claiming market may come from the discipline imposed by the claim price. When owners enter horses that are too fast relative to the field, they pay a greater price when there is a claim rule.

The cost of entering a race is the value of other races foregone. Since better horses have higher costs, the purse itself tends to limit the maximum quality of horses. These alternatives need not equal the horse's typical or average cost, $aM$. At times there will be few attractive alternative races, and lower purse races will become profitable. When this happens, and there is no claim price, an exceptionally favored horse may enter.

If the betting volume depends on having at least two horses with relatively close average speeds, the appearance of an exceptionally fast horse will

14. Jockeys tend to specialize in riding claimed horses. Aggregating jockeys into groups with at least 106 rides (so as to interpret the Chi-square), there are 8,400 rides and the $X^2$ with 33 d.f. is 79.8, which is significant beyond the 0.01 level. That is, certain jockeys ride a disproportionately large number of claimed horses. However, better horses are more likely to be claimed, and better jockeys tend to ride better horses, so the test is limited. Recording errors account for the difference between the number of rides and the number of horses.

reduce betting volumes. The claim price, by increasing the cost of entering an exceptional horse, tends to make the races more even.

If the claim rule is used to discipline owners, and not to stimulate claims, the track would have a constant target level of claims. If the intention is to sell horses by claiming, this target may result in a positive average number of claims per race. If the claim price is used to deter entry of extreme favorites, the claim price will be set to be just binding at the optimal level of the favorite. In each situation the target is a constant number of horses claimed per race.[15] That is, within the horse market theory there are several possible targets for the track. Each target implies a different average number of claimed horses per race, but each shares the essential feature that *variations* in $P/C$ are not intended to change the number of claimed horses. For any expected or target number of claims, deviations from the target level are interpreted as the result of mistakes in estimating horse prices, the number of horses entered, or in assessing parameter values, such as the cost per dollar of market value, $a$.

## X. INSTITUTIONAL DETAILS AS A TEST OF COMPETING THEORIES

The competing theories are tested with two types of data: parametric data from claiming races (such as the ratio $P/C$ versus the number of claimed horses) and with details of the institutional structure of claiming races. Both types of data are useful in judging the relative power of the theories, but in some ways the institutional evidence is the most conclusive because of the rigid assumptions required in parametric estimations.

### *Variation in P/C*

Consider the behavior of a horse marketeer in setting $P$ and $C$ where each horse owner's alternatives are proportional to the market price of horses. Since the target number of claimed horses per race would then be constant, $P/C$ must be set as a constant proportion of expected entries, $N$. In fact, among the \$10,000 claim price races, for example, the purse ranges from \$3,600 to \$8,600. Across all races $P/C$ ranges from 0.225 to 1.264. This observed variability in $P/C$ can not be explained simply by proposing that $N$ is expected to vary among races, i.e., that $P/C$ is inversely related to $N$. The ratio $P/CN$ is even more variable than $P/C$ itself, ranging from 0.19 to 1.78.

It may be overly simplistic to assume that costs are $aM$. For example, if different types of horses depreciate more quickly than others, costs would not be proportional. A type X horse worth \$10,000 might forego only \$3,600 ($a_x = 0.36$) in purses by running because it is more durable than a type Y

15. The considered theories do not explain the fact that claim prices are offered in discrete increments. However, the horse market explanation looks particularly bad in light of the size of these price differentials. At the track studied, there are only 15 different prices. These start at \$3,200, stop at \$40,000, and increase by progressively large amounts. The difference between the final two prices is \$5,000.

horse which wears out more than twice as fast and gives up \$8,600 ($a_y$ = 0.86).[16]

The magnitude of the $P/C$ range makes this possibility seem unlikely, but independent information to use as a contrast is not available. However, if the track uses variations in $P/C$ to target a constant level of claims, and $a$ differs between categories of horses, other implications follow. These are tested in the section on parametric data.

*The Restricted Right to Claim*

The right to buy claiming horses is restricted to owners and trainers. In contrast, at auctions and private sales, no such restrictions are found. If the principle reason for the claim market is to sell horses, this restriction is anomalous: it is unlikely to increase revenue.

The self-assessment aspect of this horse market, however, may explain the restriction. The fact that an expert has purchased the horse, or provided expert advice to a non-expert, may provide a more reliable signal regarding speed.

As research is expensive, and an increase in the number of searchers invariably leads to redundant research, restricting the potential buyers may reduce the total costs of obtaining information. The costs of information are significant in the monitoring theory; mitigating the size of this cost is in the interests of the track.[17] By reducing the costs of search, the track can also reduce the size of the difference between $M$ and $C$, *i.e.*, the prize money offered (indirectly) to pay for research is smaller.

The horse market theory is not entirely consistent with the restricted right to claim, but the self-assessment aspect of it is. The monitoring theory is compatible with self-assessment and, as it also explains the restricted right to claim, it is a better explanation of the claiming market.

*The Allocation of Claimed Horses by Chance*

When there is more than one claim for a horse, the horse is allocated by rolling dice. Bidding for the horse is not permitted. Since a horse market is surely in the business of collecting revenue, why would the track forego this extra income? The horse-market theory of claiming again fails the test of explaining actual behavior.

If self-assessment is a primary motive of the horse market, bidding could be used to refine the price estimate for observers. As claim prices are offered in discrete intervals, bidding might be particularly useful in this context. If price information is costly, random allocation may be used to give claimers a larger share of the returns from search. Again, the horse market theory is equivocal.

16. Without a difference in physical depreciation rates, or of nonmarket opportunities, $M$ would be bid up or down until cost equals $aM$.

17. Restricting the number of claimers also reduces the extent of redundant research and refines the price estimate for a given total search cost. See Barzel (1977) for an elaboration.

Since monitoring is costly, and bidding would eliminate gains from monitoring, the monitoring view of the claim rule would be rejected by the alternative to allocation by chance. Auctioning a claimed horse would tend to drive the difference between claim and market prices to zero, thus eliminating the payment for monitoring.

*Claimers Do Not Receive the Prize Money*

The horse market theory also fails to explain the most important detail: the rule granting the prize money to the original owner as opposed to the claimer. Under this theory granting the claimer rights to both the purse and horse prior to the start of the race would prevent the moral hazard of overriding while still capturing the benefits of closer races.

The monitoring theory, on the other hand, requires the splitting of horse and purse. Without it there is no mechanism by which the rewards from policing can be tailored to each race. This basic detail of the claim rule is, perhaps, the most important single piece of evidence, as it both refutes the horse market theory and confirms the monitoring hypothesis.

*Claim Prices verses Weight Handicapping*

Of the two competing views, only the monitoring explanation predicts all four of the previous observations. These theories share the essential assumptions of owner willingness to substitute higher incomes for fewer horses and of competition between owners. We turn now to a rule which most clearly illustrates these basic assumptions.

Every race, claiming or not, specifies a minimum weight to be carried. In some races this is the same for each horse, while in other races weight differences are used as a handicap: added weight reduces speed and, therefore, expected winnings.[18] Female horses often are given a weight advantage (typically five pounds), as are horses without previous wins. There are many other uses of weight handicapping, but only in claim races are weight reductions 'priced'.

A common practice in higher purse races is to set two or more claim prices. The owner selects a weight and claim price from the menu offered by the track; a lower weight may be purchased by accepting a lower claim price.

The willingness of owners to accept higher probabilities of losing their animals in exchange for higher expected purses, enforced by competition, implies that the track will structure the weight-claim price choice for owners so that lower weights may be obtained only at the expense of reduced claim prices. If a lower weight was assigned to a higher claim price, owners would enter only at the highest price.

In the next section, the implications of the horse market and monitoring theories are compared to the patterns of horses claimed in races. Although

18. Races also differ in the distances run. Holding the claim price-weight menu constant, there should be more claims in longer races.

these tests yield quantified probability statements, they are not inherently superior to the preceding contrast of organizational facts and theory.

## XI. THE ASSOCIATION BETWEEN PURSES, CLAIM PRICES, AND THE NUMBER OF CLAIMED HORSES

### *The 1979 Races*

Testing the parametric predictions of the claiming theory began in 1980 by recording the 1979 racing results from microfilm records of the *Seattle Times*. Due to the poor quality of the microfilm, only 495 claiming race descriptions were readable, or about one half of the claiming races. This pilot sample revealed the simple correlation between the number of horses claimed in each race and $P/C$ to be 0.35, which is "significant" beyond the 0.001 level.

This positive correlation is the basic prediction of the monitoring theory and is inconsistent with the horse market theory. The latter theory implies that *if* variation in $P/C$ is observed, it is explained as the track's response to attaining a target level of claims (given that costs are not proportional to market prices). Therefore, the number of claims should be independent of the observed values of $P$ and $C$, *i.e.*, variations in the number claimed are caused by random mistakes.

Because the poor quality microfilm may have caused recording errors, original newspaper reports were collected for the following season. A regression analysis which could be compared in detail to the later data was not performed because the cost of rereading the microfilm exceeded the negligible value of the information obtained from such a comparison. However, to the extent that the two samples are independent, the confidence levels of the regression analysis are lower bounds since they ignore the information contained in the first sample: that a random association between $P/C$ and the number of horses claimed happens by chance less than once in a thousand times.

### *The 1980 Races*

The next year's results were recorded directly from the *Seattle Times*, and included more details for each race. These 864 races (99 percent of the claim races) comprise approximately 79 percent of all races offered that year.

This simple correlation between $P/C$ and the number of horses claimed in this sample is 0.31. Like the 1979 sample, it is significant beyond the 0.001 level. If the two samples are independent, the probability that they are both generated by chance is roughly one in a million.

Table 1 presents the results of two regressions used to test the monitoring theory where the costs of determining horse prices are assumed to be unimportant. The first is an OLS estimation in which the odds spread is assumed to produce a random error in predicting the number claimed. The second estimation uses the same specification but adopts a MLE (Tobit) technique

suggested by Tobin (1958) to correct for the fact that negative claiming prices are not observable. Both estimations use the levels of $P$ and $C$ rather than their ratio.

**TABLE 1**
The Effect of the Purse, Claiming Price, and Number of Horses on the Number Claimed. ($t$-values in parentheses)

| Independent Variables | OLS | Tobit |
|---|---|---|
| Constant | 0.63 b<br>(2.8) | −0.18<br>(−0.4) |
| Purse | 0.00012 a<br>(3.9) | 0.00043 a<br>(4.8) |
| Claim Price | −0.00006 a<br>(−7.36) | −0.0002 a<br>(−9.2) |
| Number Entered | −0.0063<br>(−0.43) | −0.03<br>(−0.7) |
| $R^2$ | 0.09 | |
| LN Likelihood | | −915.2 |

Degrees of freedom = 860
Number of times the dependent variable is zero = 522.
Significant beyond the level of: a = 0.001, b = 0.01, c = 0.05.

The results of these estimations are generally consistent with the implications of the monitoring theory. Again, they also test the alternative horse market (target) theory. In the sample, claims seem to rise with increases in the purse and fall with increases in the claim price. To the extent that these data do not reject the monitoring theory requirement that the extent of claiming activity is altered by changing the combination of $P$ and $C$, monitoring is a more probable interpretation.

Table 2 presents the OLS and Tobit estimations for the information cost model. Again it seems that the number claimed is associated with the purse and claim price (this time as a ratio).

Table 3 summarizes the relationships between $P/C$ and the number of horses claimed in each race. Column 2 includes claim races where no horses were claimed. The data for races where one horse was claimed is in column 3, and so forth. The average value of $P/C$ in each category is found in row 3 and is seen to rise across columns, and the differences between all categories are significant at the 0.01 level.

The rest of Table 3 is used to assess the value of the claim price in reducing the odds spread. Column 1 includes the non-claim races. In these 182 races, the track does not set a claim price and higher average purses are offered. These races also have a lower average number of horses, and typi-

**TABLE 2**
The Effect of the Purse, Claiming Price, and Number of Horses Entered, on the Number Claimed. ($t$-values in parentheses)

| Independent Variable | OLS | Tobit |
|---|---|---|
| Constant | −0.006<br>(−0.06) | −0.18<br>(−0.33) |
| Purse/Claim Price | 0.951 a<br>(14.01) | 2.52 a<br>(9.4) |
| Number Entered | −0.004<br>(−0.35) | −0.03<br>(−0.72) |
| $R^2$ | 0.16 | |
| LN Likelihood | | −927.5 |

Degrees of freedom = 861
Significant beyond the level of a = 0.001.

**TABLE 3**
The Average $P/C$ Ratio Classified by the Number of Claimed Horses per Race: The Average Difference in Winning Probabilities in Claim and Non-Claim Races

| | (1) Non-Claim Race | (2) Claim Race | (3) Claim Race | (4) Claim Race | (5) Claim Race | (6) Claim Race |
|---|---|---|---|---|---|---|
| (1) # Races | 182 | 521 | 248 | 72 | 15 | 5 |
| (2) Number Claimed | N.A. | 0 | 1 | 2 | 3 | 4 |
| (3) Average $P/C$ | N.A. | 0.558 | 0.676 | 0.742 | 0.773 | 0.821 |
| (4) $(b_f - b_s)N$ | 1.019 | 0.644 | 0.695 | 0.697 | 0.756 | 0.418 |
| (5) $SD$ (4) | 0.903 | 0.531 | 0.615 | 0.528 | 0.607 | 0.274 |

Note: $b_f$ and $b_s$ are the pari-mutuel winning probabilities of the favorite and second favorite horses, respectively. $N$ is the number of horses in the race, and $SD$ is the sample standard deviation of (4).

cally account for two of the ten races per day. An analysis of these races as alternatives to claim races is presented in Hall (1982). For this paper their only interest lies in revealing the disciplining effect of the claim price.

Row 4 presents a measure of how close the pari-mutuel odds are between the favorite and second favorite horses. The odds have been converted to winning probabilities so that the units are consistent with Figure 1. Since non-claim races tend to have fewer horses, the probability difference is also divided by the average winning probability, $1/N$, in each race. By this measure, claim races are closer, and the difference is significant at the 0.01 level. The differences between claim race categories are not significant.

*The Difference Between the OLS and Tobit Estimates*

Some additional evidence is provided by the comparison of the OLS and Tobit regressions. Given the monitoring theory and the impossibility of observing negative numbers of claimed horses, the coefficient estimates for $P$ and $C$ should be larger and the constant smaller with the Tobit estimation.

If the track manipulates claiming by setting $P/C$, claimers would have to be paid to buy when $P/C$ falls beyond some point. This implies that the effect of $P/C$ on claiming as measured by OLS must be understated since the OLS estimate is constrained to pass through the variable means. The Tobit, by contrast, uses the prediction of the monitoring theory that zero claims are more likely as $P/C$ falls, to correct the coefficient estimates. The observed differences in estimates found in Tables 1 and 2 confirm this prediction.

*The Number Entered as a Test of the Competing Theories*

The coefficient estimate of the number of horses entered in each race provides a test of the basic monitoring model and the horse market theory. Unfortunately, the extension of the basic model to include errors in determining horse prices and information costs of claimers does not predict the sign of this coefficient. In the basic model, an increase in $N$ reduces the expected value of the purse, and market prices fall relative to claim prices. A negative coefficient estimate is found in each estimation, but in no case is it significant. Since the positive information cost model does not sign this estimate (it is confounded with the probability of incorrectly assessing prices), the latter seems to be a better explanation of these data.

The horse market theory's prediction concerning the effect of $N$ is uncertain. If the track's target is a constant number of claimed horses per race, there should be no measurable effect since $P$ and $C$ would be selected in anticipation of an $N$ in each race. The simplest interpretation of the horse market, however, is that there is a constant probability of a claim for each horse. Thus, when more horses race, more horses will be claimed.

Although there is no evidence in the regression results that when more horses race more are claimed, there may be an accidental correlation between $P$, $C$, and $N$ which obscures the 'true' effect of $N$. To test this possibility, the simple correlation between $N$ and the number claimed was also calculated. This correlation is measured as 0.034 which is positive but insignificant even at the .3 level. There is very little support for the horse market interpretation.

*Heteroscedasticity and 'Kinks'*

The possibility of heteroscedasticity in the estimations reduces confidence in all of the regression estimates of the number claimed. When $P/C$ is the regressor, the error is weighted by $c_1 N/C$ as shown in equation 5. This effect, however, may be balanced by larger variance in price when $C$ is large, because more expensive horses run when $C$ increases, and these horses

are more difficult to price.[19] The net effect is assumed to be an approximately constant variance.

Two other problems should be noted. Equations 4 and 5, taken together as $MM$, imply a discontinuous slope at $P/C = aN$, and the previous estimations ignore this feature. Regressing the number claimed on $P/C$ and $(P/C)^2$, as an approximation for the declining slope, shows the expected pattern. The coefficient on $P/C$ is again positive while the coefficient on $(P/C)^2$ is negative and both are significant. The Tobit result is below with $t$'s under the estimates:

$$\text{Number claimed} = \underset{(-6.96)}{-4.56} + \underset{(6.94)}{11.85}(P/C) - \underset{(-5.62)}{6.57}(P/C)^2 - \underset{(-0.81)}{0.03}N.$$

*Better Horses Are Claimed*

The analysis of unequal odds shows that better horses (lower odds) are more likely to be claimed. This implication of monitoring is shared by the horse market theory in the sense that only horses which are sufficiently above the target $M$ will also be above $C$. Figure 2 is used to judge the accuracy of this prediction. However, in Figure 2, $P/C$ is not controlled. To implement a control it would be necessary to use a probit or its analogue, which requires that each horse in each race be recorded with its odds and the $P/C$ of that race. Instead, a cheaper method is employed. Horses are aggregated into odds groups, and the relative frequencies of claimed horses in these groups is plotted. The $P/C$ ratio is treated as a random variable attached to the frequency. Assuming that the pari-mutuel odds are also the odds that horse owners assign to their prospects of winning, the frequency of claiming must decline with the odds.[20]

The odds and claiming associated with approximately 8,000 horses in the 864 claiming races were recorded. The scatter shows that a larger fraction of favored horses are claimed. The pattern would be even more pronounced if the first two odds categories were deleted. No explanation is offered to account for the fact that among the most favored horses no claims are observed. However, these two groups together contain only 12 horses. The number of horses in each category is shown in the legend. In short, these data support the horse market and monitoring theories.

## XII. SUMMARY AND CONCLUSIONS

The implications of the thesis that claiming prices are used to coordinate a market for monitoring services compare favorably to the facts. The ratio $P/C$ is not constant, it varies by a factor of six across races. More horses are

19. The reason for a larger variance is that higher $C$'s imply higher priced horses, and claiming races are less frequent when the price of the animals rises because of moral hazard. This means that price information is not as cheap as for lesser priced horses. The argument is more fully developed in Hall (1982).

20. It is assumed that the bettors' odds are the same as the expected winning odds of owners. With qualification, the two should tend toward equality because owners are allowed to bet.

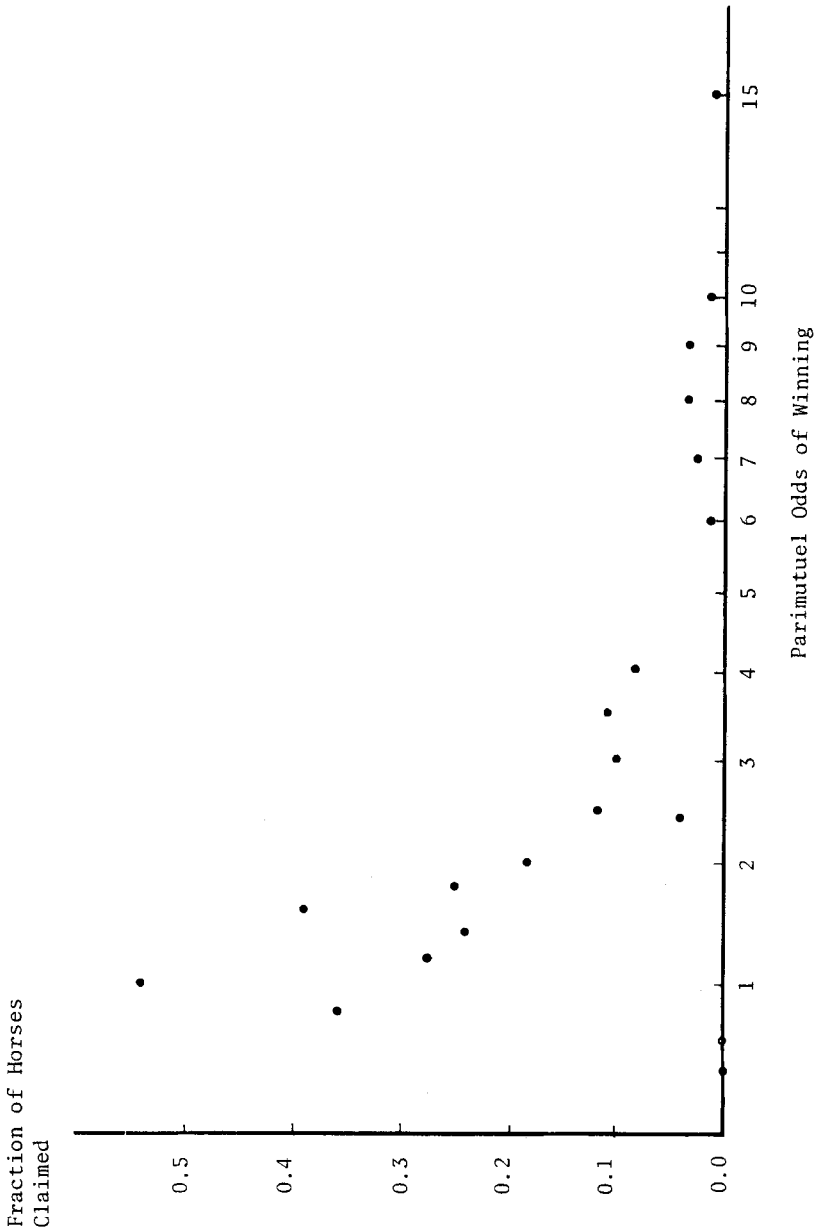
Fraction of Horses Claimed
0.5
0.4
0.3
0.2
0.1
0.0
1
2
3
4
5
6
7
8
9
10
15
Parimutuel Odds of Winning

**FIGURE 2**

claimed when the purse rises relative to the claim price, and better horses are more likely to be claimed.

The horse market theory of claiming succeeds in predicting that better horses will be claimed and that claim races will be closer than non-claim races, but these facts are also consistent with the monitoring theory. The horse market theory fails to explain the restricted right to claim, the use of dice to allocate horses when more than one claim is made, the lack of correlation between claims and the number of horses running, and the "significant" correlations between purse and claim price with the number actually claimed. Worst of all, it fails to explain why the prize money is not the property of the claimer.

We hope this study confirms the empirical importance of the growing, but all too often empty, literature on transaction costs. It follows in the tradition of Alchian and Demsetz (1972), McManus (1975), and Oi (1983), who emphasize the importance of monitoring costs in determining the design and scope of organizations. The present study, in contrast, explores a rather different method of acquiring monitoring services. It shows how one market may be coordinated to assist policing in another market. The race track invents the claiming market because it is complementary to the betting market. Its participants specialize in their information acquisition and asymmetry results. These markets do not 'fail' because of specialization, or information asymmetry. Rather, asymmetric information is the result of effectively reducing transaction costs by monitoring and pooling information.

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