Focal Points and Economic Efficiency: Role of Relative Label Salience

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We experimentally analyze efficiency-enhancing power of focal points in 2x2 Pareto-ranked coordination games. We find that the power of focal labels, when attached to the Pareto-efficient strategy, to promote efficiency critically depends upon the alternative strategy's label salience. When the relative salience of our focal labels is considerably weaker, focal labels mostly fail to raise expected efficiency beyond the mixed-strategy prediction. But when the relative salience of our focal labels is markedly stronger, focal labels raise expected efficiency much beyond the mixed-strategy prediction. Furthermore, we find that focal labels' efficiency-enhancing power decreases as a measure of risk-dominance increases across games.

Keywords: Coordination game, Equilibrium selection, Focal point, Payoff-dominance, Risk-dominance.

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1. Introduction

Thomas Schelling's *The Strategy of Conflict* (1960) is considered as one of the most influential books in the history of social science. In this masterpiece, Schelling introduced the concept of focal points and first demonstrated their existence in *pure* coordination games; later, Mehta *et al*. (1994a, b) replicated his informal experiments under controlled laboratory conditions. Although unconventional for standard game theory, these studies used a *label-based* focal points approach, in which strategies are distinguished by labels (*e.g*. words, pictures, or anything else that players can recognize), and generated expected coordination rates that are considerably higher than random play would suggest in these games. Players in pure coordination games thus tend to make use of salient labels to their mutual benefit and an equilibrium that results from such choices constitutes a *focal point*.

The successful application of focal points in pure coordination games raises the possibility that players in *Pareto-ranked* coordination games may also make strategic use of labels and thus replicate the earlier success of focal points in this important class of coordination games. The coordination problem embedded in a Pareto-ranked coordination game is, however, more involved than that of in a pure coordination game. The perennial concern in such a game is how to coordinate players' choices on the Pareto-efficient equilibrium, not just coordinating on any equilibrium. Therefore, it is natural to inquire whether attaching salient labels to the Pareto-efficient strategy in these games can select the most efficient equilibrium. While the matter appears to be ripe for empirical attention, yet curiously, there is no study of which we are aware that analyzes the role of focal points in implementing the Pareto-efficient equilibrium in these games. The first objective of our study is to address this omission and thereby advance our knowledge of focal points.

The second objective of our study is to determine the power of focal points against a forceful equilibrium selection device that is applicable to Pareto-ranked coordination games. Experimental studies on Pareto-ranked coordination games have repeatedly demonstrated that subjects in these games are more likely to select the most inefficient equilibrium, the more risk-dominant that equilibrium is; thus subjects' play is not governed by the Paretian efficiency.[1] But there exists no research that analyzes how focal labels, when attached to the Pareto-efficient strategy, would perform against the risk-dominance principle. This is surprising because focal points and risk-dominance can be made to be simultaneously present in Pareto-ranked games and they both may influence players' decisions, and still, our knowledge about their relative influence remains severely limited. The second objective of our study aims to rectify this limitation. We assess the power of label-based focal points against the risk-dominance principle by systematically varying a measure of risk-dominance (due to Selten, 1995) in a sequence of Pareto-ranked games while controlling for the payoff-dominance characteristic.

[1]There is substantial evidence against the claim that people use payoff-efficiency to solve the equilibrium selection problem in coordination games with Pareto-ranked equilibria. Some examples include Schmidt *et al*. (2003), Battalio *et al.* (2001), Straub (1995), Crawford (1991), and Van Huyck *et al*. (1990). For surveys of this massive literature, see Kagel & Roth (1995) and Camerer (2003).

We address these two objectives by utilizing a sequence of 2x2 symmetric stag-hunt games.[2] In each of our games, one equilibrium is payoff-dominant (PD) and the other is risk-dominant (RD). Given identical equilibrium payoffs across the games, the payoff-dominance principle predicts the same frequency of play of the PD strategy in all of these games. Thus, the payoff-salience in each game is held at a common level. The games, however, systematically differ from each other in one crucial aspect: the magnitude of the risk-dominance measure of the payoff-dominated equilibrium (discussed in section *3*). Based on this measure and the related results in the literature, we would expect lower frequency of play of the PD strategy in games with a larger magnitude of the risk-dominance measure.

Our plan, as indicated above, is to attach to the PD strategy in each game labels, one at a time, which we have found to possess strong focal power[3]. If both of the players jointly recognize the salience of the label attached to the PD strategy, then a rule of selection may emerge that would lead the players to choose that label and thus efficient coordination may ensue. As a consequence of the above plan, the following concern

[2]Our choice of this specific coordination game was motivated by three factors. First, the conflict between efficiency and risk has made stag-hunt games the canonical example of the equilibrium selection problem. Second, among the three most important classes of coordination games (pure coordination games, divergent-interest games of which the Battle-of-the Sexes is an example, and common-interest games with Pareto-ranked equilibria of which stag-hunt is an example), stag-hunt games are the only coordination games in which focal points, risk-, and payoff-dominance can be *simultaneously* dealt with. Third, the game has been subjected to considerable laboratory scrutiny, which facilitates interpretation of our results within a broad literature.

[3]According to Schelling, some decision labels have "some kind of prominence or conspicuousness" (1960, *p*. 57) that makes those labels more salient than others. Similarly, Lewis (1969) coins the term of *salience* – uniqueness in some conspicuous respect. In the remainder of this study, we use the term "focal" in the sense of the salience of a decision label. Sugden (1995) develops a formal theory of focal points by explicitly introducing the labeling of strategies into the analysis and aims at a "general theory of how labels can influence decisions in games".

arises: what label should we attach to the alternative strategy in these games? More generally, do the labels attached to alternative strategies in a *strategic form* coordination game make any difference for a *given* focal label's ability to promote successful coordination?[4] An answer to this question will not only shed light on the concept of "relative salience" of a decision label, that is, how the salience of a given label is affected by the label salience of an alternative strategy, but it will also supply important inputs for our experimental design. Furthermore, an affirmative finding would reshape our understanding of the way label-based focal points function in strategic form coordination games and thus may have serious efficiency implications when applied to Pareto-ranked coordination games.

We decided to conduct a brief "verification" experiment utilizing a 2x2 pure coordination game (Figure 1) and let the results of this experiment to inform our design of the subsequent treatments. When strategies are labeled, the pure coordination games are considered ideal for filtering out factors that might induce players to choose one strategy rather than another and thus isolating the pure effects of labels. To this end, we attached the label "Year 2009" to one strategy and attached the labels "Year 2008" and "Year 1999", one at a time, to the "other strategy" in our pure coordination game. This labeling procedure generated two treatments: in the first treatment, the "other strategy" is

[4]Mehta *et al*. considered one set of pure coordination games of the following form: "[W]rite down any year, past, present, or future", in which players' strategy sets were infinite. As a result, the issue of labeling of alternative strategies was suppressed. But if one attempts to explore the role of focal points in coordination games (pure or Pareto-ranked) represented in the strategic form, such a concern is certain to arise. Schelling (1960) considered games in both forms, but expressed his concern (*p*. 96) regarding the extent to which the success of focal points in pure coordination games with infinite strategy set can be transferred to strategic form games. Furthermore, Schelling wondered about the possible effects of alternative methods of labeling strategies in a strategic form coordination game.

labeled as "Year 2008", and in the second treatment, the "other strategy" is labeled as "Year 1999". We conjectured that "Year 2009" possesses stronger salience than the other two labels, and "Year 2008" possesses stronger salience than "Year 1999".[5] Separate groups of 60 subjects participated in each treatment and played the corresponding treatment only once for the equivalent dollar amounts as shown in Figure 1. Any significant difference in the frequency of play of "Year 2009" between the treatments can be attributed only to the label of the "other strategy".

In the first treatment, 70 percent of subjects (pooled across player roles as the symmetry would suggest) chose the label "Year 2009", thereby achieving an expected coordination rate of 58 percent. In the second treatment, by contrast, 80 percent of subjects chose the label "Year 2009", thereby achieving an expected coordination rate of 68 percent. Clearly, "Year 2009" has stronger salience than the other two labels in our subject population. But more importantly, the frequency of play of the label "Year 2009" increased by 14 percent when we altered the label of the "other strategy" from "Year 2008" to "Year 1999" (a z-test of the difference in the proportions of "Year 2009" generated a statistic of 1.26, $p < 0.10$).

Thus, the focal power of a given label seems to critically depend on the label salience of an alternative strategy in a pure coordination game. This is a useful insight for properly addressing our research objectives. If we are not careful enough in choosing the label of the alternative strategy in our three 2x2 stag-hunt games, then we may seriously

[5]Mehta *et al.* (1994a, b) found "current year" to be a strong focal point in pure coordination games. Since our experiment was conducted in 2009, we chose the label "Year 2009". We discuss a rule in Subsection *3.2* according to which the alternative strategy's labels can be ranked.

misjudge the efficiency-enhancing power of focal points in our experiment. In terms of the efficiency implications of such an oversight, a 14 percent difference might translate into a huge loss or gain, especially if the payoff in the PD equilibrium is considerably higher than that of in the Pareto-dominated equilibrium.

Being equipped with this insight, we attach focal labels to the PD strategy in each game, one at a time. For each focal label we attach to the PD strategy in each game, we attach two different labels to the alternative strategy in each game, one at a time, much in the same way as in our "verification" experiment. Thus, the above labeling procedure yields two treatments for each of our stag-hunt games under each focal label – one treatment in which the relative salience of the PD strategy's label is weaker and another treatment in which the relative salience of the PD strategy's label is stronger, when the treatments are compared to each other. We explore two types of labels that implement the above procedure; one is textual while the other one is diagrammatical in nature.

The experimental data reveal some surprising and yet robust results. Can a *given* focal label facilitate efficient coordination in 2x2 symmetric stag-hunt games? As anticipated, the answer critically depends on the relative salience of the PD strategy's label. When the relative salience of the PD strategy's label is weaker, each of the focal labels that we used plainly fails to raise the expected *efficient* coordination rate even to the level prescribed by the mixed-strategy play in each of our games except the one with the lowest measure of risk-dominance. When the relative salience of the PD strategy's label is stronger, each of our focal labels raises the expected efficient coordination rate much above the level prescribed by the mixed-strategy play in each of our games except the one with the highest measure of risk-dominance. In our experiment, a systematic manipulation in the relative salience of the PD strategy's label between treatments raised expected efficient coordination rate by as much as 167 percent and payoff-efficiency by as much as 75 percent.

The above result has an important corollary. Since Schelling's investigations, it may have been implicitly believed in the literature that the drawing power of a focal label is *absolute* in the sense that it is independent of how alternative strategies are labeled. Our results show that this belief may be misplaced. We show that by altering the label salience of an alternative strategy in a sequence of 2x2 Pareto-ranked coordination games, one may influence the relative salience of a given focal label and thus may dilute or enhance the drawing power of that label in fostering coordination.

How does a *given* focal label perform against the risk-dominance principle in 2x2 symmetric stag-hunt games? There is clear evidence that regardless of the relative salience of the PD strategy's label, the capacity of a given focal label to stimulate efficient coordination decreases monotonically as the Pareto-dominated equilibrium becomes more risk-dominant across our games. Although, the importance of the relative salience of the PD strategy's label is very much prominent even when the risk-dominance of the Pareto-dominated equilibrium is very high. In the stag-hunt game with the highest level of risk dominance that we considered, expected efficient coordination rate increased by as much as 167 percent and payoff efficiency by as much as 50 percent when the relative salience of the PD strategy's label was stronger than when it was weaker.

The rest of the paper is organized as follows. Section *2* briefly discusses the relevant literature. Section *3* introduces the experiment. Section *4* reports the results, while section *5* concludes.

2. Related Literature

In this section, we briefly discuss how our study fits into the broad literature on experimental coordination games. Our study appeals to the three streams of research within this literature and we discuss each of them in turn.

The idea of focal points has attracted considerable attention from experimental economists. Besides the classic contributions by Mehta *et al*. (1994a, b), studies by Bardsley *et al*. (2009), Blume & Gneezy (2000), and Bacharach & Bernasconi (1997) have extended generous support to the effectiveness of label salience as a source of focal points in solving coordination problems. Specifically, Bardsley *et al*. (2009) designs an experiment to distinguish between alternative explanations of *how* players use label-based focal points to select equilibria in one-shot pure and Pareto-ranked coordination games. Blume & Gneezy (2000) examines the role of endogenous focal points in pure coordination games that lack a common description. Bacharach & Bernasconi (1997) investigates the variable frame theory of focal points in pure coordination games. Crawford *et al*. (2009) is an exception that points out the limited role of label-based focal points in achieving coordination success in the constant sum battle-of-the sexes games. None of the above studies, however, analyzes the effectiveness of label-based focal points in Pareto-ranked coordination games like we do. Our study aims to fill this gap in the literature.

Legions of experimental studies have sought ways to implement the Pareto-efficient outcome in various types of Pareto-ranked coordination games; nevertheless, in this massive literature there is no study of which we are aware that analyzes the role of focal points as an efficiency-enhancing device.[6] Our study contributes to this large literature by examining the role of yet another important selection device in this well-known class of coordination games.

Finally, there is a relatively small but growing literature that analyzes the relative strengths of risk- and payoff-dominance principles in Pareto-ranked coordination games (*cf*. footnote 1). But these studies do not explore the nature of interaction between focal points and the two dominance principles in a unified framework, even though all of them can be simultaneously present in Pareto-ranked games. The current study explores such an avenue of research.

3. Experiment

[6]There is a large body of literature that documents the effectiveness of various selection devices in solving the equilibrium selection problem in two broad classes of experimental coordination games with Pareto-ranked equilibria. *2X2 coordination games*: one- and two-way communication (Cooper *et al*. 1992), forward induction (Cooper *et al.* 1992), past actions and observability (Duffy & Feltovich 2006), cheap talk and past action (Duffy & Feltovich 2002), role of payoff- and risk-dominance (Schmidt *et al.* 2003; Battalio *et al.* 2001; Straub 1995), labeling of subjects (Van Huyck *et al.* 1997), payoff disparity between equilibria and its impact on the choice of Pareto-efficient equilibrium (Friedman 1996), cheap talk (Clark *et al*. 2001; Charness 2000), network structure (Cassar 2007). *Higher-order coordination games*: cheap talk (Blume & Ortmann 2007), inter-group competition (Bornstein *et al.* 2002), loss avoidance (Cachon & Camerer 1996), use of dominated strategies (Cooper *et al.* 1990), precedent transfer (Devetag 2005), use of informal sanctions (Dugar 2009), cost of coordinating on the Pareto-efficient equilibrium (Goeree & Holt 2005), local interaction on a network (Keser *et al*. 1998), inter-generational advice (Chaudhuri *et al*. 2009), group size (Van Huyck *et al.* 1990), asset market competition (Van Huyck *et al.* 1993), credible external assignment of actions (Van Huyck et al. 1992), financial incentives in terms of bonuses (Brandts & Cooper 2006), various facial and physical gestures (Manzini *et al*. 2009), manager-employee communication (Brandts & Cooper 2007), adaptive dynamics (Crawford 1995), evolutionary dynamics in large and small groups (Crawford 1991).

This section is divided into three subsections. Subsection *3.1* introduces a measure of risk-dominance for a generic 2x2 symmetric stag-hunt game and then attaches three sets of values to the parameters of the generic game, thus creating three distinct stag-hunt games. This subsection also derives the theoretical predictions for each game. Subsection *3.2* introduces the two labeling schemes used in the experiment and provides rationale behind their use. Subsection *3.3* presents the experimental session-specific information and states the testable hypotheses.

3.1 The Stag-Hunt Games

Consider the generic 2x2 symmetric game shown in Figure 2. Each player i (= 1, 2) has a finite set S_i of pure strategies; the elements of S_i are denoted by s_{ij} where j = 1, 2. Figure 2 shows the payoffs to the players for each pair of strategies. Let $a > c$ and $b > d$. The generic game then has two pure-strategy Nash equilibria at (s_{11}, s_{21}) and (s_{12}, s_{22}), and a Nash equilibrium in mixed strategies with $p_{i1}^{*} = \frac{b-d}{(a+b)-(c+d)}$ where p_{i1} is the probability with which player i chooses strategy s_{i1}. The strategy pair (s_{11}, s_{21}) strictly payoff-dominates (s_{12}, s_{22}) if $a > b$. A Nash equilibrium is considered strictly PD if it is strictly Pareto-superior to all other Nash equilibria in a game. In other words, a PD equilibrium offers a strictly higher payoff to each player than any other equilibria in a game. Selten (1995) advanced a measure of risk-dominance that we employ here to calculate the risk-dominance of the inferior equilibrium. Following our notation, Selten's (1995, *p.* 221) weighted average log measure of risk-dominance of the equilibrium (s_{12}, s_{22}) over (s_{11}, s_{21}) is given by:

$$R = Log\left[\frac{u_1(s_{12}, s_{22}) - u_1(s_{11}, s_{22})}{u_1(s_{11}, s_{21}) - u_1(s_{12}, s_{21})}\right] = Log\left(\frac{b-d}{a-c}\right).$$

If R is positive, then (s_{12}, s_{22}) is RD. If R is negative, then (s_{11}, s_{21}) is RD, which is never the case in the games we study. If R is zero, then the symmetric mixed-strategy Nash equilibrium is RD. Let $b - d > a - c$, which ensures the risk-dominance of the equilibrium (s_{12}, s_{22}) over (s_{11}, s_{21}). With two pure-strategy Nash equilibria, one of which is Pareto-dominant while the other one is risk-dominant, our generic game now is a *stag-hunt* coordination game. Notice that, by manipulating the off-diagonal parameters (c and d) while keeping the diagonal parameters (a and b) unchanged in our generic stag-hunt game, we can vary the measure of R.

Next, we attach three sets of values, which follow the above restrictions, to the parameters in Figure 2 to generate three stag-hunt games that we utilize in our experiment. The games are given in Figure 3. In each game, (s_{11}, s_{21}) and (s_{12}, s_{22}) are the PD and the RD equilibria, respectively, and s_{i1} and s_{i2} are the PD and the RD strategies, respectively, for each player i. The games share the same payoff-dominance characteristic; the measures of risk-dominance, however, are different across these games. Table 1 lists the following characteristics for each game: the magnitude of the risk-dominance measure (R), the probability, for each player, with which the PD strategy is to be chosen in each pure-strategy and symmetric mixed-strategy Nash equilibrium. The table also includes the probability of coordination (Pr(C)), the probability of *efficient* coordination (Pr(EC)), the probability of efficient coordination conditional on coordination (Pr(EC/C)), the expected earnings, and the "payoff- efficiency" for each equilibrium. The "payoff-efficiency" is defined as the sum of the payoffs of the two players, normalized so that the maximum possible joint payoff in a given game has an efficiency of 1 and the minimum has an efficiency of zero. As Table 1 shows, the risk-dominance measures for the three games are R = log(1), R = log(1.5), and R = log(3); we denote the games by L, M, and H, respectively.

3.2 The Labeling Schemes

In this study we use the term *label* to describe how a strategy is presented to a player in our experiment. A label can be a number, a letter, a name, a color, or a shape, etc. In this study, as in Crawford *et al*. (2009), Bardsley *et al*. (2008), Bacharach & Bernasconi (1997), and Mehta *et al.* (1994a, b), we exogenously assign distinct labels to the strategies, for each player, of our stag-hunt games. A *labeling scheme* of a game thus assigns a label $L(s_{ij})$ to each strategy s_{ij} of player i, such that each strategy for player i has a distinct label. When the strategies are labeled, players choose among the labels to indicate their choice of a strategy.

We adopt two different types of labeling schemes for our experiment – one is textual and the other is graphical; the schemes are denoted as YEAR (Y) and DOT (D), respectively. The above three stag-hunt games are subjected to each labeling scheme separately in our experiment. Under the Y scheme, which we already discussed in Section *1*, the strategies are labeled as names of years; players decide on a strategy by choosing between the two year-names. Under the D scheme, the strategies are labeled as dots on a straight line; players decide on a strategy by choosing one of the two dots on the line. The common element in the two schemes, which is exploited by our design, is that, within each scheme, there exists a natural ranking of the labels in terms of their distance (over time or space) from one another.

We require each of the labeling schemes to satisfy the following two criteria. First, under each scheme, the label attached to the PD strategy must possess a considerably higher level of salience than those of the labels attached to the alternative strategy in each game. This seems a natural criterion to have given that our first objective is to generate as much efficient coordination as possible using strong focal labels. Second, the salience of the labels attached to the alternative strategy in each game must differ from each other in such a manner so that they have discernible impact on the relative salience of the PD strategy's label. The second criterion appears to be a logical prerequisite for understanding the implication of varying the relative salience of the PD strategy's label in the stag-hunt games; this is especially appealing given the results from our "verification" experiment stated earlier. We checked whether each labeling scheme meets these two criteria by conducting a verification experiment for each of them. Each verification treatment uses a 2x2 pure coordination game with labeled strategies, considered ideal for isolating pure effects of labels.

Under the Y scheme, we label the PD strategy in each game as "Year 2009", which is the current year during which the experiment is conducted. Given the finding in Mehta *et al*. (1994a, b), we expect "Year 2009" to have strong focal power. In order to vary the relative salience of the PD strategy's label under this scheme, the alternative strategy in each game is labeled as either "Year 2008" or "Year 1999". The results reported in Section *1* have already verified that the two criteria are satisfied by the Y scheme in a pure coordination game. In view of those results, the Y scheme generates two treatments for each of the three stag-hunt games – a "Strong" (S) treatment in which the relative salience of the PD strategy's label is stronger (*i.e.*, the alternative strategy's label is "Year 1999") and a "Weak" (W) treatment in which the relative salience of the PD strategy's label is weaker (*i.e.*, the alternative strategy's label is "Year 2008"). We expect that in each game the frequency of play of the PD strategy's label to be higher when the alternative strategy's label is "Year 1999" than when it is "Year 2008".

Why may subjects treat the label "Year 2008" differently than the label "Year 1999", when attached to the alternative strategy in each game? One may apply the "rule of closeness" (discussed in Mehta *et al*. 1994b, *p*. 169) to shed light on this question. The rule emerges from mutual recognition of a close association or proximity between, for example, two objects. The concept can be understood as a rule specifying a spatial relation, a relation in terms of color, time etc. between labels. Moreover, the rule has been previously shown to be used by players in coordination games to choose among labels. According to this rule, "Year 1999" is further from "Year 2009" than "Year 2008" is from "Year 2009". As a result, players applying this rule may find the label "Year 2009" relatively more salient when that label is contrasted against "Year 1999" than when it is contrasted against "Year 2008".[7]

[7] We suspect that the labels in each scheme can also be ranked in terms of their salience (primary, secondary, or Schelling) in the population, but for our purpose this information is not essential. See Mehta *et al.* 1994a, b for their definitions.

Under the D scheme, the PD strategy in each game is labeled as the "Middle dot" on a straight line. Schelling (1960, *p*. 57) and a large number of studies related to the Ultimatum game experiments (see for example, Guth *et al.*, 2001) have found that "equal division" possesses strong salience. Based on these findings, we expect "Middle dot" to have strong focal power. To vary the relative salience of the PD strategy's label, the alternative strategy in each game is labeled as a second dot on the left of the midpoint and its distance from the midpoint is changed.[8] The second dot is placed either at a short distance from the midpoint ("Close left dot") or at a longer distance from the midpoint ("Distant left dot") (see Figure 3). We ran a brief "verification" experiment, similar to the previous one, for the D scheme as well to check whether the alternative strategy's labels have a similar impact on the relative salience of the PD strategy's label. Interestingly, the results from these treatments are exactly the same as those from the treatments under the Y scheme reported in Section *1*.[9] In view of these results, the D scheme generates two treatments for each of the three stag-hunt games – a "Strong" (S) treatment in which the relative salience of the PD strategy's label is stronger (*i.e.*, the alternative strategy's label is "Distant left dot") and a "Weak" (W) treatment in which the relative salience of the PD

[8]After initial experimentation, we found out that positioning the second dot on either side of the midpoint does not affect the quality of subjects' decisions.

[9]"Middle dot" is chosen 70% of the time when paired with "Close left dot" and 80% of the time when paired with "Distant left dot". Using the corresponding proportions of choice for each of the two treatments, we reject the null hypothesis that the choices are equally likely in that treatment (for the treatment with "Close left dot", $z = 3.10$, $p < 0.001$; for the treatment with "Distant left dot", $z = 4.65$, $p < 0.001$). This confirms that "Middle dot" indeed have higher salience than the two alternative strategy labels. But more importantly, the frequency of play of the label "Middle dot" increased by 14 percent when we altered the label of the "other strategy" from "Close left dot" to "Distant left dot" (a z-test of the difference in the proportions of "Middle point" generated a statistic of 1.26, $p < 0.10$). These two results confirm that the D scheme also meets the two criteria stated earlier. Our design does not allow us to comment on what *type* of salience was induced in this experiment. Subjects may have played according to primary, secondary, or Schelling salience.

strategy's label is weaker (*i.e.*, the alternative strategy's label is "Close left dot"). We expect that in each game the frequency of play of the PD strategy's label to be higher when the alternative strategy's label is "Distant left dot" than when it is "Close left dot".

The relation between the labels used in the D scheme can also be understood by applying the rule of closeness: "Distant left dot" is further from the "Middle dot" than "Close left dot" is from the "Middle dot". As a result, players applying this rule may find the label "Middle dot" relatively more salient when that label is contrasted against "Distant left dot" than when it is contrasted against "Close left dot".

Since both of our proposed labeling schemes have successfully met both the criteria, we decided to employ these schemes in our experiment. The two labeling schemes coupled with our three stag-hunt games therefore generate a total of 12 (2x3x2) treatments listed in Table 2. We recognize that for any individual, the relative salience of these labels would depend on matters of age, taste, culture, nationality and other personal associations. However, in our design, the cultural determinants of salience are held constant as much as possible by subjecting all the treatments to the same population of students, thus permitting direct tests of the label-specific effects. In the following, we describe the session-specific features of these 12 treatments.

3.3 The Sessions

As indicated above, we have a total of 12 treatments corresponding to the three stag-hunt games. Each of these treatments was played by a separate group of 60 subjects. The parameter values reported in subsection *3.1* have been used in the actual experiment as equivalent dollar amounts. Each treatment consisted of two experimental sessions in each of which a group of 30 subjects participated in a one-shot game. For each treatment, one session was conducted at the San Diego State University and the other was conducted at the University of Calgary. During a session, upon arrival at the lab, each subject was randomly assigned a registration number and given a copy of the instructions. They were also given a "Decision Sheet" where they could indicate their choices.[10] After the instructions were read aloud, the subjects were asked to make their decisions on the Decision Sheet only *once*, which mentioned their registration numbers. After the subjects were done, the decision sheets were collected. The subjects were then randomly paired by picking up two decision sheets at a time in a random manner. The registration numbers of the subjects within the pair and their choices were then publicly announced and written on a white board. We also wrote on the board the money each registration number earned by looking up at the payoff matrix of the game the session was playing. The subjects were paid privately in cash right after the session.[11] Each session lasted for less than 30 minutes.

[10]In the Y scheme, the subjects wrote down their choices while in the D scheme they circled the dot of their choice on a diagram similar to Figure 3.

[11]Subjects also received 5 US or Canadian dollars, as the case may be, as a show-up fee in addition to their earnings in the experiment.

Now, before we proceed to the discussion of the results from the experiment, we would like to clearly state our two general hypotheses.

Hypothesis 1: The frequency of play of the PD strategy's label in each stag-hunt game is expected to be higher when the relative salience of the PD strategy's label is relatively stronger (S treatment) than when it is relatively weaker (W treatment).

Hypothesis 2: Under a given labeling scheme (Y or D), in each treatment (S or W) the frequency of play of the PD strategy's label is expected to be lower, the higher the measure of risk-dominance (*R*).

4. Results

The results from the experiment are presented in Figure 5. The upper panel diagrams correspond to the D scheme and the lower panel diagrams correspond to the Y scheme. A diagram under a given labeling scheme shows both the absolute and the relative frequencies with which the two strategies are chosen in each of the three games; the maximum possible absolute frequency in each game is 60. The most interesting feature of the data is revealed when we compare, for a given labeling scheme, the choice frequencies of the PD strategy between the W and the S treatment of a given game.

Consistent with our Hypothesis 1, we find that, under each labeling scheme, the PD strategy's choice frequency is higher in the S treatment than in the corresponding W treatment in each game. Under the D scheme, these frequencies are 60%, 45% and 25% in L-DOT_W, M-DOT_W and H-DOT_W, respectively, which increase to 85%, 60% and 40% in L-DOT_S, M-DOT_S and H-DOT_S, respectively. Under the Y scheme, the frequencies are 80%, 55% and 26.7% in L-$YEAR_W$, M-$YEAR_W$ and H-$YEAR_W$, respectively, which increase to 90%, 75% and 41.7% in L-YEAR$_S$, M-YEAR$_S$ and H-YEAR$_S$, respectively.[12] Notice that these frequencies are rather different than the corresponding mixed-strategy Nash equilibrium predictions (Table 1). According to the mixed-strategy play, the choice frequency of the PD strategy will increase as the magnitude of the risk-dominance measure increases across our games, which is just the opposite of what we observe in the experimental data. In sum, the data bear remarkable evidence that the PD strategy labels "Year 2009" and "Middle dot" possess stronger salience than the corresponding alternative strategy labels, and the efficiency-enhancing power of these two focal labels seem to critically depend upon the label salience of the alternative strategy. These results are reminiscent of our findings from the two "verification" experiments.

To further scrutinize the magnitude of change in the choice frequency of the PD strategy between the W and the S treatment in each game and under each scheme, we construct Table 3. This table compares the absolute frequencies of the PD strategy between the W and the S treatment for each of the three games under each labeling scheme. In agreement with our observation in the preceding paragraph, in each game under each scheme the choice frequency of the PD strategy always registers an increment in the S treatment when compared to the corresponding W treatment. On the average

[12] In Schmidt *et al.* (2003), in the one-shot experiment with a stag-hunt game with $R = 0$, the PD strategy was played only 60% of the time, which is the same as the lowest we ever get in L-DOT$_W$. In their experiment, the strategies were labeled as "A" and "B". We recognize that the payoff-dominance measure of the game in question in Schmidt *et al*. (2003) was 0.4, which is slightly lower than the 0.5 measure in our study. We also know that subjects in their experiment decreased the choice of the PD strategy, for a given level of R, as the payoff-dominance measure was increased. Therefore, when comparing the choice frequencies of the PD strategy in L-DOT$_S$, L-DOT$_W$, L-YEAR$_S$, and L-YEAR$_W$ with that of Schmidt *et al*.'s corresponding treatment, one may attribute the choice frequency of the PD strategy beyond 60% to the focal power of our PD strategy labels, and not to the payoff-dominance feature.

(across games and labeling schemes), the PD strategy is chosen 39 times in the S treatment, whereas the same strategy is chosen 29 times in the W treatment, thus resulting in an average increase of 34.5% between the two treatments. In both of the schemes, this increment attains the maximum in Game H; the frequency of the PD strategy increases by as much as 60% in Game H. Each row of Table 3 also reports a *z*-test statistic. A casual inspection reveals that the difference in the choice frequencies of the PD strategy between the S and the W treatment in each game under each labeling scheme is highly significant. Raising the relative salience of a given PD strategy label thus makes a statistically significant difference in terms of the frequency with which the most efficient strategy is chosen in each game we consider.

Next, we analyze the impact of increasing the relative salience of a given focal label on coordination and efficiency. By utilizing the relative frequencies of the strategy choices, Table 4 lists the probability of coordination (Pr(C)), probability of efficient coordination (Pr(EC)), the probability of efficient coordination conditional on coordination (Pr(EC|C)), the expected earnings, and the payoff efficiency for each game under each labeling scheme.

First, we focus on the statistic Pr(C). We find that, under each scheme, Pr(C) in Game L and Game M are higher when the relative salience of the PD strategy's label is stronger than when it is weaker. The S treatment under each scheme, however, fails to produce higher expected coordination rate in Game H. In fact, Pr(C) decreases in the two S treatments in this game. The reason may be the following. In Game H, the alternative strategy is highly risk-dominant (R = log(3)), and therefore risk-dominance attains relatively higher prominence as an effective coordination device. As a result, when the relative salience of the PD strategy's label is enhanced in the S treatment in Game H, some subjects may have chosen the alternative strategy being swayed by the risk-dominance criterion, while other subjects may have chosen according to the label salience principle. The conflicting drawing powers of label salience and risk-dominance thus may have raised the chance of miscoordination and resulted in a lower expected coordination rate in Game H. But recall that when the equilibria are Pareto-ranked, our goal is not just to achieve higher coordination; but we would like to achieve higher coordination on the PD equilibrium. The fact that Pr(C) decreases in the S treatment of Game H under each labeling scheme does not necessarily imply that efficiency will also be lower in this game.

To examine if we can achieve higher efficiency when the relative salience of a given PD strategy label is enhanced, we concentrate our focus on Pr(EC), expected earnings, and the payoff-efficiency. Table 4 shows that not only Pr(EC), but Pr(EC|C) is also higher in the S treatment than in the corresponding W treatment in each game under each labeling scheme, and these increases are sometimes pretty large. On the average (across labeling schemes), when the relative salience of a given PD strategy label is stronger, Pr(EC) increases by 63.3%, 83.3% and 154.8% in Game L, Game M and Game H, respectively. On the average (across labeling schemes), when the relative salience of a given PD strategy label is stronger, Pr(EC|C) increases by 22.9%, 61.3% and 96.7% in Game L, Game M and Game H, respectively. Notice that, the effect of manipulating the relative salience of a given PD strategy label on Pr(EC) and Pr(EC|C) is at its highest level when the risk-dominance of the alternative strategy is also at the highest among the levels we considered. On the average (across labeling schemes and games), Pr(EC) and Pr(EC|C) increase by 70.4% and 45.8%, respectively, between the S and the W treatment. We also notice that, in Game L and Game M, both Pr(EC) and Pr(EC|C*)* in the S treatments are higher than the symmetric mixed-strategy predictions in these games (Game L: 0.25 and 0.50; Game M: 0.36 and 0.69, respectively).

Since both Pr(EC) and Pr(EC|C) are higher in the S treatment than in the corresponding W treatment in each game under each labeling scheme, it is obvious that expected earnings would also be higher in the S treatments than the corresponding W treatments in these games. It is, however, to our surprise that Pr(EC), Pr(EC|C), and expected earnings are higher in the S treatment than in the corresponding W treatment in Game H as well. On the average (across games and labeling schemes), the expected earnings increase from $3.86 in the W treatment to $4.39 in the S treatment – a 13.7% increase. In Game L and Game M but not in Game H, the S treatments achieve higher expected earnings than predicted by the corresponding mixed-strategy predictions in these games ($4.00 and $4.20 in Game L and Game M, respectively).

The increase in expected earnings we discussed above readily indicates a considerable improvement in the payoff efficiency in the S treatments when compared to the corresponding W treatments. We see in Table 4 that the efficiency value is higher in each W treatment than in the corresponding S treatment. An efficiency of 0.69 is the highest that we achieve among all of the W treatments, while the highest is 0.84 among all of the S treatments. An efficiency of 0.14 is the lowest that we achieve among all of the W treatments, while the lowest is 0.21 among all of the S treatments. On the average (across games and labeling schemes), the efficiency increases from 0.33 in the S treatment to 0.51 in the W treatment – a 54.5% increase. Even though we failed to achieve higher Pr(C) in the S treatments compared to the corresponding W treatments in Game H, yet we are able to gain in payoff efficiency by more than 46% in each S treatment than the corresponding W treatment for this game. Given our knowledge from previous studies regarding the difficulty in achieving the efficient outcome in the presence of a highly risk-dominant outcome, our success in Game H is substantial. Moreover, in Game L and Game M, the S treatments achieve higher efficiency than the corresponding mixed-strategy predictions in these games (0.33 and 0.40 in Game L and Game M, respectively). All the results discussed above provide strong support for our Hypothesis 1.

In order to test our Hypothesis 2, we compare the choice frequency of the PD strategy across games in a given treatment condition (W or S) under a given labeling scheme (Y or D). Consistent with our hypothesis and the findings in previous studies (Schmidt *et al*., 2003), we find that the proportion of the PD strategy decreases as the risk-dominance of the alternative strategy increases across our games – the proportion of the PD strategy is lower in Game M than in Game L and, again, in Game H than in Game M. Under the D scheme, the proportions of the PD strategy are 60% (W) and 85% (S) in Game L which decrease to 45% (W) and 60% (S), respectively, in Game M and then to 25% (W) and 40% (S), respectively, in Game H. We find a similar trend under the Y scheme. Since we observe a similar pattern across treatments and labeling schemes, our results supplement the previous finding by suggesting that subjects' responsiveness to changes in R in stag-hunt games is independent of the relative salience of a given PD strategy label and the type of labels (textual or graphic) used.

We bring our discussion of the results to an end with a comparison between the two labeling schemes in terms of the success we achieve by manipulating the relative salience of a given PD strategy label. When we look at the percent increase in the PD strategy frequency in Table 3, we find that the Y scheme does better than the D scheme in two of the three games (L and H). In terms of percentage increase in the probability of coordination, probability of efficient coordination, expected earnings and efficiency in the W treatments, the comparison between the two schemes is inconclusive; neither scheme has consistently performed better than the other one except in Game L where the Y scheme consistently outperformed the D scheme.

5. Conclusion

The goal of this paper was to examine how a given salient label, when attached to the Pareto-dominant strategy, may enhance efficiency by making the most efficient equilibrium in a 2x2 Pareto-ranked game focal. The results of our precursor experiment reveled that the power of a given salient label to produce a focal point depends on the label of the alternative strategy – it's the relative salience, not the absolute salience, of a label that determines the strength of the focal point that a given salient label might generate in a strategic-form pure coordination game. Based on these results, in our main experiment, we hypothesized that the frequency of play of the Pareto-dominant strategy will be higher when the relative salience of its label is relatively stronger. The results from the experiment have supported the hypotheses; we achieved a substantial increase in efficiency when the relative salience of the label for the Pareto-dominant strategy was strengthened, even when the risk-dominance of the alternative strategy was very high. In fact, the effect of manipulating the relatively salience was at its highest level when the risk-dominance of the alternative strategy was at the highest among the levels we considered. These findings confirmed that focal points can indeed help achieve higher efficiency and highlights the importance of being careful when labeling the alternative strategy.

We also examined how three selection devices (namely, payoff-dominance, risk-dominance and focal points) when present simultaneously in a game may affect choice of strategies. Our experimental results have supplemented the literature by showing that raising the risk-dominance level of the alternative strategy while keeping the payoff-dominance level of the Pareto-dominant strategy constant reduces the frequency of play of the Pareto-dominant strategy and this trend is independent of the relatively salience of the label attached to the Pareto-dominant strategy and the type of labels (textual or graphical) assigned to the strategies. The findings of the current study have advanced our knowledge about focal points and their applicability, and how they perform in contrast and combination with other selection devices. Future extensions of the study can focus on the generalizability of the knowledge to higher order games.

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Instructions for the Y scheme, *R* = 0 game

Welcome to this experiment. You have been randomly assigned a registration number, which is written on the other side of this page. This number will be used to identify you during the experiment. Your real identity will remain strictly anonymous during and after the experiment.

In this experiment you will play a game with another person only once and the amount of money you will receive from the experiment would depend on both of your decisions. In this experiment we will pay you in Canadian dollars and we will pay you privately at the end of the experiment.

Please do not talk to others while the experiment is in progress. The game that will be played by each of you is introduced next.

Game

You will be randomly paired with another person in this room. Both you and this other player you are paired with will separately and independently select an option. Both of you will only have two options to choose from: Year 2009 and Year 2008. Based upon your combined decision, you and the other player will be able to earn money. There are four possible situations:

1. If both of you choose Year 2009, then both of you will earn $6.
2. If both of you choose Year 2008, then both of you will earn $3.
3. If you choose Year 2008 and the other player chooses Year 2009, then you will earn $5 and the other player will earn $2.
4. If you choose Year 2009 and the other player chooses Year 2008, then you will earn $2 and the other player will earn $5.

At the end of the experiment, you will be in one of these four situations.

Procedure

After everyone finishes making their choice, the assistant will collect all the decision pages. Then the assistant will randomly draw two decision pages at a time. The two registration numbers on these two decision pages will form a pair. The assistant will then write down those two registration numbers and list each player's choice on the whiteboard. This will inform you about the other person's (with whom you are matched with) choice and how much money each of you made. You will never be told during or after the experiment the identity of the other player in your pair.

Please write down your choice (either Year 2009 or Year 2008) in the designated space provided on the next page, when you are ready. Please raise your hand when you are done recording your choice; the assistant will come to you and collect this decision page.

After the assistant is finished with drawing all the decision pages, the experiment will come to an end. You are now requested to wait outside the room. Your name will be announced to pay you in private. Please raise your hand if you have any questions. The assistant will be happy to answer those questions. Thank you for your participation!

Figures

Figure 1. The pure coordination game

Player 2

Player 1		s_{21}	s_{22}
	s_{11}	5, 5	2, 2
	s_{12}	2, 2	5, 5

Figure 2. A generic 2x2 stag-hunt game

Player 2

Player 1		s_{21}	s_{22}
	s_{11}	*a, a*	*d, c*
	s_{12}	*c, d*	*b, b*

Figure 3. The Dot (D) scheme

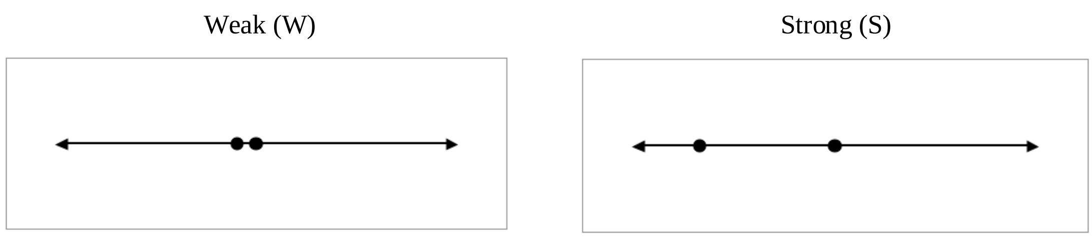


Figure 4. The three stag-hunt games

Player 2

Player 1		s_{21}	s_{22}
	s_{11}	6, 6	2, 5
	s_{12}	5, 2	3, 3

Game L

Player 2

Player 1		s_{21}	s_{22}
	s_{11}	6, 6	1.5, 5
	s_{12}	5, 1.5	3, 3

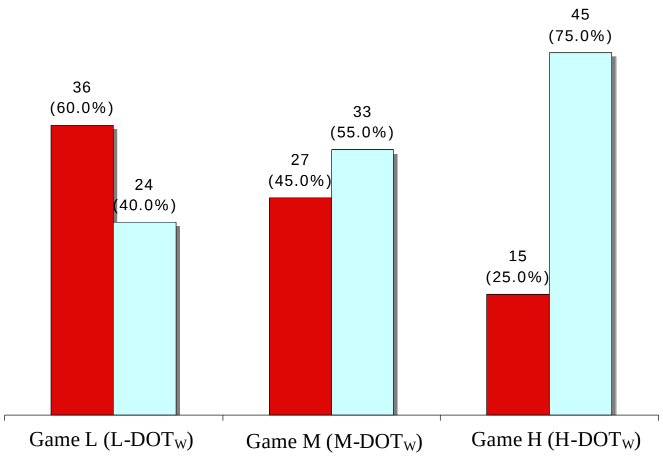
Game M

Player 2

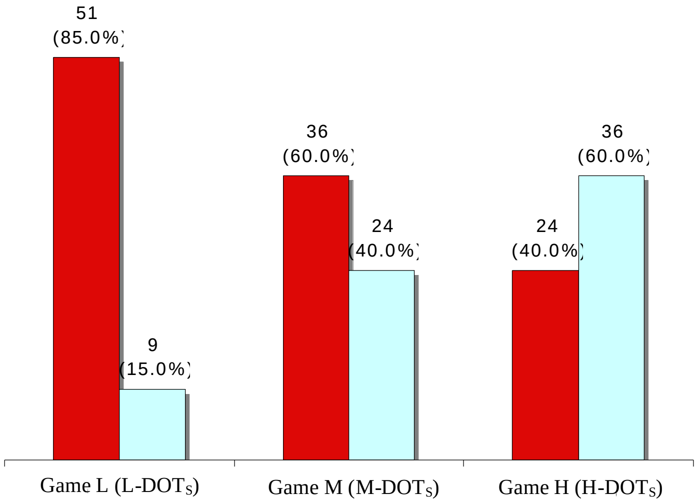
Player 1		s_{21}	s_{22}
	s_{11}	6, 6	0, 5
	s_{12}	5, 0	3, 3

Game H

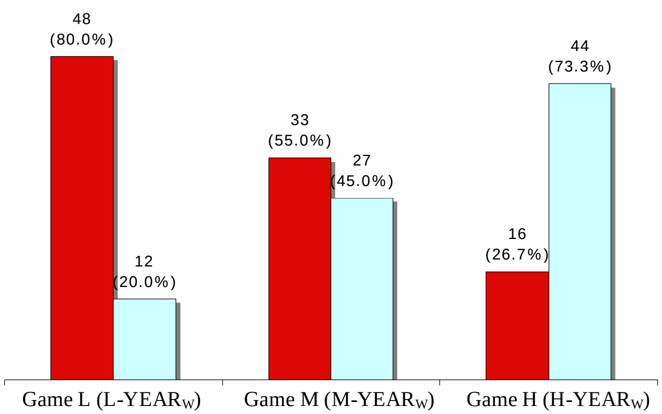
Figure 5. Absolute and relative frequencies of the PD and the alternative strategies (the PD strategy in the darker shade)



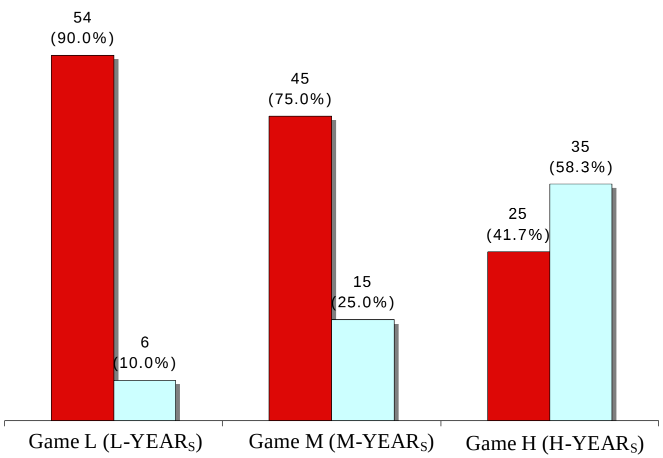
DOT Scheme – W Treatments



DOT Scheme – S Treatments



YEAR Scheme – W Treatments



YEAR Scheme – S Treatments

Tables

Table 1. The theoretical predictions for the three games

Game Indexed by R	Magnitude of R	Equilibrium: $(Pr(s_{11}), Pr(s_{21}))$	Pr(C)	Pr(EC)	Pr(EC|C)	Expected Earnings	Payoff Efficiency
L	Log (1) = 0	(1, 1) (0, 0) (0.50,0.50)	1 1 0.50	1 0 0.25	1 0 0.50	\$6.00 \$3.00 \$4.00	1 0 0.33
M	Log (1.5)	(1, 1) (0, 0) (0.60, 0.60)	1 1 0.52	1 0 0.36	1 0 0.69	\$6.00 \$3.00 \$4.20	1 0 0.40
H	Log (3)	(1, 1) (0, 0) (0.75, 0.75)	1 1 0.63	1 0 0.56	1 0 0.89	\$6.00 \$3.00 \$4.50	1 0.14 0.57

Table 2. Experimental design: 12 treatments

Game Indexed by R	Labeling Scheme			
	YEAR (Y)		DOT (D)	
	Relative Salience of the PD Strategy Label		Relative Salience of the PD Strategy Label	
	Weak (W)	Strong (S)	Weak (W)	Strong (S)
L	L-$YEAR_W$	L-$YEAR_S$	L-DOT_W	L-DOT_S
M	M-$YEAR_W$	M-$YEAR_S$	M-DOT_W	M-DOT_S
H	H-$YEAR_W$	H-$YEAR_S$	H-DOT_W	H-DOT_S

Note: Each treatment is named in the following manner: the first letter denotes the magnitude of the risk-dominance measure, the second word denotes the specific labeling scheme, and the subscript denotes the degree of relative salience of the PD strategy label.

Table 3. Frequency of the PD strategy in each game under each scheme

Game Indexed by R	Labeling Scheme	Frequency of the PD Strategy		Percentage Increase in S	*Z*-Statistic	*p* -value
		W	S			
L	YEAR	36	51	41.7%	3.07	0.00
	DOT	48	54	12.5%	1.53	0.06
M	YEAR	27	36	33.3%	1.65	0.05
	DOT	33	45	36.4%	2.30	0.01
H	YEAR	15	24	60.0%	1.75	0.04
	DOT	16	25	56.3%	1.73	0.04
Average		*29*	*39*	*34.5%*	-	-

Table 4. Expected coordination, earnings and efficiency (mixed-strategy Nash predictions are in parentheses)

Game Indexed by *R*	Labeling Schemes	Pr(C)			Pr(EC)			Pr(EC|C)			Expected Earnings			Payoff Efficiency		
		W	S	% Increase in S	W	S	% Increase in S	W	S	% Increase in S	W	S	% Increase in S	W	S	% Increase in S
L	YEAR	0.52	0.74	42.3%	0.36	0.72	100.0%	0.69	0.97	40.6%	$4.32	$5.30	22.7%	0.44	0.77	75.0%
	DOT	0.68	0.82	20.6%	0.64	0.81	26.6%	0.94	0.99	5.3%	$5.08	$5.52	8.7%	0.69	0.84	21.7%
		(0.50)			(0.25)			(0.50)			($4.00)			(0.33)		
M	YEAR	0.50	0.52	4.0%	0.20	0.36	80.0%	0.40	0.69	72.5%	$3.73	$4.20	12.6%	0.24	0.40	66.7%
	DOT	0.50	0.62	24.0%	0.30	0.56	86.7%	0.60	0.90	50.0%	$4.03	$4.78	18.6%	0.34	0.59	73.5%
		(0.52)			(0.36)			(0.69)			($4.20)			(0.40)		
H	YEAR	0.62	0.52	-16.1%	0.06	0.16	166.7%	0.10	0.31	210.0%	$3.00	$3.24	8.0%	0.14	0.21	50.0%
	DOT	0.61	0.51	-16.4%	0.07	0.17	142.9%	0.12	0.34	183.3%	$3.02	$3.28	8.6%	0.15	0.22	46.7%
		(0.63)			(0.56)			(0.89)			($4.50)			(0.57)		
Average		*0.57*	*0.62*	*8.8%*	*0.27*	*0.46*	*70.4%*	*0.48*	*0.70*	*45.8%*	*$3.86*	*$4.39*	*13.7%*	*0.33*	*0.51*	*54.5%*