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Signaling with Audits: Mimicry, Wasteful Expenditures, and Non-Compliance in a Model of Tax Enforcement*

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Abstract

The audit policy of a tax authority can signal its audit effectiveness. We model this process and show that in limited circumstances an ineffective authority can masquerade as being effective. We show that high maximal penalties imply underreporting of income.

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A tax enforcement regime must have well-calibrated audit policies and penalties to ensure compliance and revenue collection. The private nature of a taxpayer's income makes this calibration difficult in theory and in practice. Often, however, the authority or bureau in charge of enforcing a tax code also has enforcement-relevant private information. Specifically, it knows how good it is at detecting hidden income or uncovering other transgressions. A *strong* bureau has capacity to uncover hidden income while a *weak* bureau does not.[1] A taxpayer's beliefs about the bureau's effectiveness feed directly into compliance incentives. If he believes the authority is weak, non-compliance is tempting since meaningful sanction is unlikely. We argue that enforcement practices can inform those beliefs with many implications for equilibrium audit efficacy.

In this note we construct a simple model with double-sided private information where an agency's auditing mechanism may signal enforcement-relevant information. We formalize three main conclusions. First, a weak bureau may be able to masquerade as a strong agency. We call this "thrifty enforcement" as the bureau need not have (possibly costly) capacity to perform its mission—the agent must simply think it does. Surprisingly, this outcome is possible only if the bureau *cannot* impose large penalties. Second, it may be costly for a strong bureau to reveal its type convincingly. Revelation may require wasteful expenditures. Finally, we show that when penalties for non-compliance are too large, compliance is necessarily imperfect. This contrasts with classic results on law enforcement with risk-neutral agents (Becker, 1968).

Since Allingham and Sandmo (1972) a large literature has considered the design of auditing regimes. The problem's modern formulation was provided by Reinganum and Wilde (1985) and expanded upon by Border and Sobel (1987), Mookherjee and Png (1989), and Chander and Wilde (1998). Our model is closest in spirit to Cronshaw and Alm (1995). In their analysis, the taxpayer knows his own income and the tax authority has private information regarding its audit costs and audit effectiveness. We model audit effectiveness similarly but our model differs in terms of timing and the bureau's commitment ability. They do not study the signaling implications of audit mechanisms. Snow and Warren (2005) also consider a setting with imperfect audit effectiveness. We elaborate on the policy and legal implications of our analysis in Kotowski et al. (2013), which draws on the model and results developed below.

[1] For example, the Internal Revenue Service (IRS) attempts to collect tax on Americans' world-wide income. For many years the agency was relatively weak in identifying hidden income abroad. Recently, its strength on this front may have improved. See, for example, M.V. "Arresting developments," *The Economist Schumpeter Blog*, October 23, 2013, accessed January 27, 2014, http://www.economist.com/node/21588302.

1 Model

The agent ("taxpayer") must pay tax on his income. It is common knowledge that with probability f_0 his income is low (w_0) and with probability f_1 it is high (w_1). The agent's income (i.e. type) is his private information. Let $t(w)$ be the statutory tax liability of an agent with income w. To simplify exposition, let $t_i \equiv t(w_i)$ and (without loss of generality) set $t_0 = 0$. The agent is risk-neutral and would like to minimize his payments to the government.

The principal ("bureau" or "tax authority") is an enforcement agency charged with collecting tax. The bureau has a privately-known type, $s \in \{0, 1\}$. The bureau's type is a parameter determining its auditing effectiveness, as we describe further below. It is common knowledge that the bureau is of type s with probability g_s.

Ideally, the bureau would like an agent with income w to pay $t(w)$ in taxes out of his own initiative. Obviously, such an outcome is unlikely. Following common practice, the bureau administers a self-reporting taxation scheme with ex post auditing to incentivize compliance. The idea should be familiar to anyone who has paid income tax and is summarized by the timeline in Figure 1.

1. Aware of its type, the bureau announces and commits to an enforcement mechanism $\langle \alpha, \beta \rangle$.[2] The mechanism specifies an audit rule (α) and a post-audit payment schedule (β).

2. Aware of $\langle \alpha, \beta \rangle$ and his income, the taxpayer submits an income report, $\hat{w}$.

3. An agent reporting $\hat{w}$ is audited with probability $\alpha(\hat{w})$. The cost of an audit to the bureau is $c > 0$.

   (a) If no audit occurs, the agent pays $t(\hat{w})$ in taxes.

   (b) If an audit occurs, its outcome depends on the bureau's type. If the bureau is of type $s = 1$, the agent's true income is revealed. Otherwise, the audit is inconclusive and confirms the agent's original declaration.[3] If w_a is the agent's audit-identified income, he must pay $\beta(\hat{w}, w_a)$.

[2] The issue of commitment has received considerable attention in the auditing literature. See, for example, Reinganum and Wilde (1986) or Khalil (1997).

[3] Cronshaw and Alm (1995) relate audit effectiveness to the principal's type similarly.

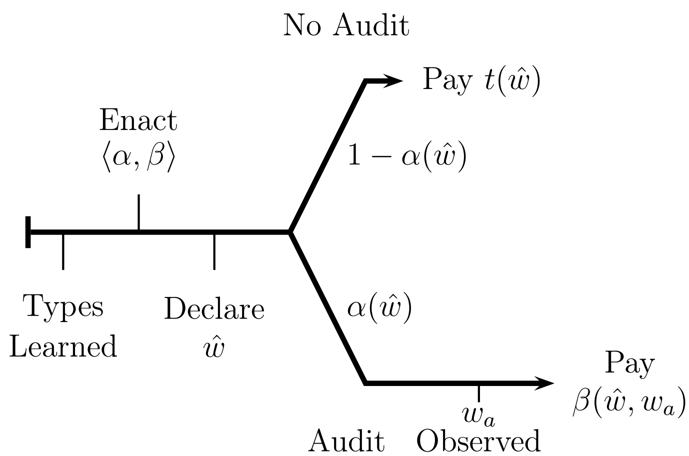

Figure 1: Audit game timeline.

Given the role of s, we call a type-1 bureau "strong" and a type-0 bureau "weak." In crafting an enforcement mechanism, the bureau's goal is to maximize collected receipts net of audit costs, i.e. its "profits." The bureau is risk-neutral.

We do not allow the bureau to employ any $\langle \alpha, \beta \rangle$, as this would be empirically and technically misguided. Often, enforcement agencies must work within commonly-accepted bounds or laws.

Definition 1. Let $\bar{\beta} > 0$. The mechanism $\langle \alpha, \beta \rangle$ is *feasible* (with respect to $\bar{\beta}$) if: (i) the bureau cannot impose a penalty greater than $\bar{\beta}$, i.e. $\beta(\hat{w}, w_a) \leq \bar{\beta}$; (ii) the bureau cannot reward an audited agent, i.e. $\beta(\hat{w}, w_a) \geq t(\hat{w})$; and, (iii) the bureau cannot penalize an agent who overstates his audit-determined income, i.e. $\hat{w} \geq w_a \implies \beta(\hat{w}, w_a) \leq t(\hat{w})$.

Feasible mechanisms capture many real-world practices. The bound on $\beta(\hat{w}, w_a)$ rules out "optimal" but pathological enforcement schemes that rely on arbitrarily harsh punishments (Becker, 1968). Typically, maximum penalties are codified by legislators and an enforcement agency, such as the U.S. Internal Revenue Service, is given discretion within some range. Reflecting common practice, we preclude rewarding an agent who experiences the unpleasantries of an audit.

By restricting attention to feasible mechanisms, we can identify the post-audit payment function with a single number, denoted by β, which equals the levy imposed after a discovered underreport.[4] When describing a mechanism we will at most specify the triplet α_0, α_1, and

[4]Feasibility implies $\beta(w_0, w_0) = t_0 = 0$ and $\beta(w_1, w_0) = \beta(w_1, w_1) = t_1$. Only $\beta(w_0, w_1)$ remains to be specified.

β, where α_i is the probability that an agent reporting w_i is audited.

An enforcement strategy for a type-s principal is a probability distribution over feasible mechanisms. A reporting strategy for a type-w taxpayer specifies a probability distribution over income reports for each feasible enforcement mechanism. Our solution concept is (weak) Perfect Bayesian Equilibrium.[5]

Before turning to the analysis, we record a maintained assumption.

Assumption A-1. *$f_1\bar{\beta} > f_0 c$ and $\bar{\beta} > t_1$.*

This assumption ensures that a strong bureau does not opt to not audit simply because auditing is too expensive, type-w_1 agents are too rare, or allowable penalties are too low. It ensures our conclusions are not trivial. All proofs are in the appendix.

2 Analysis

An initial observation regarding the agent's behavior is immediate.

Lemma 1. *It is weakly dominant for a type-w_0 agent to report w_0. (Proof omitted.)*

We henceforth assume that a type-w_0 agent always reports w_0.

As a benchmark, suppose the bureau's type is known. If the bureau is weak ($g_0 = 1$), the situation is trivial. The agent always reports w_0 and no tax is collected. If the bureau is strong ($g_1 = 1$), our model reproduces a classic result in the auditing literature. The bureau audits low reports, but this is an (ex post) superfluous activity.

Proposition 1. *Suppose $g_1 = 1$. The optimal enforcement mechanism is such that $\alpha_0^* = t_1/\bar{\beta}$, $\alpha_1^* = 0$, and $\beta^* = \bar{\beta}$. The agent truthfully reports his income.*

Now suppose $g_s \in (0, 1)$. As in most signaling games, there is a multiplicity of equilibria. Moreover, our flexible parameterization implies many cases. To highlight our framework's interesting conclusions we emphasize equilibria where the agent complies with the prevailing law—at least when facing a strong bureau. This is analogous to the result in Proposition 1 and would be of practical interest to policy makers. As we detail below, such equilibria may not always exist.

[5]See, for example, Mas-Colell et al. (1995, p. 285).

Result 1: Thrifty Enforcement. In analogy to physical exercise, it is often costly for a bureau to become strong. Developing a capacity to identify hidden income, for example, may necessitate hiring more capable staff. In lieu of such investments, a weak bureau may wish to adopt a strong agency's posture hoping that its stance is sufficiently convincing to beget compliance. If the agent cannot discern the bureau's strength, he may comply to hedge his bets. Such an outcome, however, is possible only when the admissible penalty structure meets several key bounds.

Proposition 2. *There exists a pooling equilibrium where a type-w_1 agent truthfully reports his type if and only if $t_1/g_1 \leq \bar{\beta} \leq c/g_0$.*

When a weak bureau mimics a strong bureau, it imposes a negative externality on its stronger counterpart. The bound on $\bar{\beta}$ stops the equilibrium's unraveling by preventing the strong bureau from profitably "de-pooling" to an alternative enforcement scheme.

Result 2: Costly Revelation. Sometimes a strong bureau may wish to project its strength. In a separating equilibrium, weak and strong bureaus employ different mechanisms, say m^0 and m^1 respectively. Thus, the agent can infer the bureau's type from the prevailing regime. Clearly, a type-w_1 agent will report w_0 when he is convinced that the bureau is weak. Hence, a weak bureau collects zero revenue in a separating equilibrium. Therefore, m^1 must generate even less revenue when employed by a weak bureau.

Proposition 3. *There exists a separating equilibrium where a type-w_1 agent truthfully reports his type to a type-1 bureau if and only if $\bar{\beta} \leq c/f_1$.*

As outlined in proposition's proof, a strong bureau may engage in "wasteful expenditures" to add credence to its signal.[6] The associated intuition is analogous to Spence (1973).

Result 3: High Penalties and Non-Compliance. In the preceding two cases, to ensure truthful reporting the maximal admissible penalty ($\bar{\beta}$) could not be too large. When $\bar{\beta}$ exceeds those thresholds, compliance become imperfect.

Proposition 4. *Suppose $c/g_0 < \bar{\beta}$ and $c/f_1 < \bar{\beta}$. In every equilibrium a type-w_1 agent underreports his income with strictly positive probability to a strong bureau.*

[6] In the model, wasteful expenditures emerge as excessive and superfluous auditing. In practice, such an expenditure may be a lavish head office.

A policy implication of Proposition 4 is that compliance may improve following a *reduction* in the admissible penalties.

Although large penalties imply complex taxpayer behavior, they also impact the kinds of audit schemes the tax authority may employ in an equilibrium. Pooling equilibria, for example, may no longer be attainable even when agent compliance is imperfect.

Proposition 5. *Suppose* $c/f_1 < \bar{\beta} < c(2 - f_1)/f_1$ *and* $c/g_0 < \bar{\beta}$*. There does not exist a pooling equilibrium.*

Given Proposition 5, it is natural to ask what *does* happen when penalties are large? Here matters become complex and the equilibrium constructions are delicate. Proposition 4 ensures imperfect compliance by high income agents. At the same time, pooling and separating outcomes may be out of the question. Thus, a weak bureau may adopt a strategy of partial mimicry—implying a semi-separating equilibrium—as it randomizes between a revealing mechanism and the strong bureau's policy. The agent's imperfect compliance ensures that a weak bureau's return conditional on employing a strong bureau's strategy is not greater than that of a revealing policy.

3 Concluding Remarks

We have developed a model of tax enforcement where the enforcement mechanism can convey information regarding the principal's effectiveness in enforcing a law. Although we have phrased our model in a setting of auditing and tax compliance, analogous results continue to apply in any similarly-structured law-enforcement problem.

Our model suggests several avenues for future research. Endogenizing agents' tax liability or considering the full mechanism-design problem in an informed-principal setting are but two challenging opportunities.

A Appendix: Proofs

Proof of Proposition 1. A bureau may employ a mechanism where either (i) a type-w_1 reports w_1 or (ii) a type-w_1 agent reports w_0.

(i) If the bureau's mechanism encourages honest reporting, the optimal mechanism maximizes $f_0(-\alpha_0 c) + f_1(t_1 - \alpha_1 c)$ subject to $t_1 \leq \alpha_0 \beta$. The solution is $\alpha_0 = t_1/\bar{\beta}$, $\alpha_1 = 0$, and $\beta = \bar{\beta}$. The bureau's expected profits are $f_1 t_1 - f_0 c t_1/\bar{\beta}$.

(ii) If the bureau's mechanism encourages underreporting, the optimal mechanism maximizes $\alpha_0 (f_1\beta - c)$ subject to $\alpha_0\beta \leq t_1$. If $f_1\bar{\beta} \geq c$, then $\alpha_0 = t_1/\bar{\beta}$, $\alpha_1 = 0$, and $\beta = \bar{\beta}$ is optimal. This is the same mechanism as in part (i) but the agent's reporting strategy implies that the bureau's profit is $f_1t_1 - ct_1/\bar{\beta}$. If $f_1\bar{\beta} < c$, setting $\alpha_0 = 0$ maximizes profits, which are 0.

Given Assumption A-1, $f_1t_1 - f_0ct_1/\bar{\beta} \geq \max\{0, f_1t_1 - ct_1/\bar{\beta}\}$. Therefore, the mechanism and agent behavior from case (i) maximize profits. □

Proof of Proposition 2. ($\Rightarrow$) Let m^* be a mechanism employed in a pooling equilibrium. Given m^*, the agent maintains his prior beliefs. Since truth-telling is optimal for a type-w_1 agent, $g_1\alpha_0^*\beta^* \geq t_1 \implies \bar{\beta} \geq t_1/g_1$. Additionally, the bureau's profits are $f_1t_1 - \alpha_0^* f_0 c$. Suppose a strong principal employs $\tilde{m} \neq m^*$ where $\tilde{\alpha}_0 = t_1/(g_1\bar{\beta}) - \epsilon$. If $\tilde{m}$ is to lead to a lower profit than m^* a type-w_1 agent must report w_0 with positive probability. Thus, for all $\epsilon > 0$,

$$\left(\frac{t_1}{g_1\bar{\beta}} - \epsilon\right)(f_1\bar{\beta} - c) \leq f_1t_1 - \alpha_0^* f_0 c \leq f_1t_1 - \left(\frac{t_1}{g_1\bar{\beta}}\right) f_0 c \implies \bar{\beta} \leq c/g_0.$$

($\Leftarrow$) Suppose $t_1/g_1 \leq \bar{\beta} \leq c/g_0$ and consider a mechanism m^* where $\alpha_0^* = t_1/(g_1\bar{\beta})$, $\alpha_1^* = 0$, and $\beta^* = \bar{\beta}$. If both bureau types employ m^*, a type-w_1 agent reports w_1. Next we specify off-equilibrium path beliefs for a type-w_1 agent. If the agent encounters $\tilde{m} \neq m^*$ suppose his beliefs are as follows:

(i) If $\tilde{\alpha}_0 \geq t_1/(g_1\tilde{\beta})$, then the agent maintains his prior beliefs. Consequently, he reports w_1.

(ii) If $\tilde{\alpha}_0 < t_1/(g_1\tilde{\beta})$, then the agent believes that the bureau is weak. Consequently, he reports w_0.

All mechanisms meeting condition (i) generate profits less than m^*. Auditing is more frequent but reporting is unchanged. In case (ii), the bureau's expected profits are $\tilde{\alpha}_0(f_1\tilde{\beta} - c)$. If $f_1\tilde{\beta} - c \leq 0$, then the bureau's profits are less than zero. However, m^* yields non-negative profits. If $f_1\tilde{\beta} - c > 0$, then the bureau's profits are at most $\left(\frac{t_1}{g_1\tilde{\beta}}\right)(f_1\bar{\beta} - c)$, which is less than $f_1t_1 - \alpha_0^* f_0 c$ since $\bar{\beta} \leq c/g_0$. Therefore, m^* is compatible with a pooling equilibrium where a type-w_1 agent reports w_1. □

Proof of Proposition 3. ($\Rightarrow$) In a separating equilibrium a weak bureau prefers to employ m^0 over m^1 and a strong bureau prefers to employ m^1 over m^0. Thus, $0 \geq -f_0\alpha_0^1 c + f_1(t_1 - \alpha_1^1 c)$ and $-f_0\alpha_0^1 c + f_1(t_1 - \alpha_1^1 c) \geq 0$. Hence, expected equilibrium profits for weak and strong bureaus is zero. Suppose a strong bureau deviated to $\tilde{m} \neq m^*$ where $\tilde{\alpha} = t_1/\bar{\beta} - \epsilon$ and $\tilde{\beta} = \bar{\beta}$. In response a type-$w_1$ agent will report w_0. Equilibrium implies that $0 \geq \tilde{\alpha}_1(f_1\bar{\beta} - c) \implies \bar{\beta} \leq c/f_1$ because $\epsilon > 0$ is arbitrary.

($\Leftarrow$) Suppose m^0 is a mechanism that does not audit any reports and m^1 is such that $\beta^1 = \bar{\beta}$ and the audit probabilities satisfy $t_1/\bar{\beta} \leq \alpha_0^1 = f_1\left(t_1/c - \alpha_1^1\right)/f_0$. To verify that there exist admissible values for α_0^1 and α_1^1, it is sufficient to note that (i) $t_1/\bar{\beta} < f_1 t_1/(f_0 c)$ (by Assumption A-1) and that (ii) $f_1\left(t_1/c - 1\right)/f_0 < 1$.[7] m^1 generates expected profits of zero and a type-w_1 agent truthfully reports w_1. If a type-w_1 agent reports only w_0 off of the equilibrium path, $\bar{\beta} \leq c/f_1$ ensures that a strong bureau does not have a profitable deviation. □

Proof of Proposition 4. The proof is by contradiction. Let m^1 be a mechanism employed in equilibrium by a strong bureau. Suppose that a type-w_1 agent reports w_1 given m^1. We will show that a strong bureau must also employ some other mechanism, after which a type-w_1 agent reports w_0 with positive probability. Let $g_1^{m^1}$ be the agent's posterior belief that the bureau is of type-1 conditional on m^1. Truth telling implies that $g_1^{m^1}\alpha_0^1\beta^1 \geq t_1$. The bureau's equilibrium expected profits are $f_1 t_1 - f_1\alpha_1^1 c - f_0\alpha_0^1 c$.

If instead a strong bureau employed a mechanism that audited low reports with frequency $t_1/\bar{\beta} - \epsilon$ and imposed a penalty of $\bar{\beta}$, a type-w_1 agent would report w_0. This would yield profits of $(t_1/\bar{\beta} - \epsilon)(f_1\bar{\beta} - c)$, which is strictly positive because $c/f_1 < \bar{\beta}$. Therefore, a strong bureau's equilibrium profits must be strictly positive as well. But this implies a weak bureau's equilibrium profits must also be strictly positive, as it could always m^1 guaranteeing itself the same profits.

An argument like that in the proof of Proposition 2 shows that $\bar{\beta} \leq c/g_0^{m^1}$. However, $\bar{\beta} > c/g_0$. Therefore, $g_0^{m^1} < g_0$. Thus, there must exist some other mechanism $\tilde{m}$ such that $g_0^{\tilde{m}} > g_0$. Clearly, $g_0^{\tilde{m}} < 1$, else the mechanism $\tilde{m}$ would generate zero profits for a weak bureau. Therefore a strong bureau must employ $\tilde{m}$ with some probability as well. If a type-w_1 agent always reported w_1 given $\tilde{m}$, the same argument as above would imply that $g_0^{\tilde{m}} < g_0$—a contradiction. Therefore, a type-w_1 agent must report w_0 with positive probability given $\tilde{m}$. □

[7]The second claim is true since $f_1\bar{\beta} \leq c \implies f_1 t_1 < c \implies f_1 t_1 - f_1 c < f_0 c \implies f_1(t_1 - c) < f_0 c$.

Proof of Proposition 5. Suppose there exists a pooling equilibrium where m^* is employed by both types of bureau. Let $\bar{\beta} > \max\{c/g_0, c/f_1\}$. By Proposition 4, a type-w_1 agent must report w_0 with positive probability given m^*. Let $\tau > 0$ be the probability with which he reports w_0. In this pooling equilibrium, a strong bureau must earn strictly positive profits. Indeed, if a strong bureau employs a mechanism $\tilde{m}$ where $\tilde{\alpha}_0 = t_1/(\bar{\beta} - c)$, $\tilde{\alpha}_1 = 0$, and $\tilde{\beta} = \bar{\beta}$, its profits are $f_1 t_1 - f_0 t_1 c/(\bar{\beta} - c) > 0$.

Suppose $\tau = 1$. For a strong bureau to earn strictly positive profits, $\alpha_0^* > 0$. However, this implies that a weak bureau earns profits less than zero when it employs m^*—a contradiction. Therefore, $0 < \tau < 1$. If a type-w_1 agent is to randomize his report, $g_1 \alpha_0^* \beta^* = t_1$. Since m^* must generate profits at least as great as $\tilde{m}$ for a strong bureau, we have that

$$\begin{aligned}
f_1 t_1 - \frac{f_0 t_1 c}{\bar{\beta} - c} &\leq \tau \alpha_0^* (f_1 \beta^* - c) + (1 - \tau)(f_1(t_1 - \alpha_1^* c) - f_0 \alpha_0^* c) \\
&= \frac{\tau t_1 (f_1 \beta^* - c)}{g_1 \beta^*} + (1 - \tau)\left(f_1(t_1 - \alpha_1^* c) - \frac{f_0 t_1 c}{g_1 \beta^*}\right) \\
&\leq \frac{\tau t_1 (f_1 \bar{\beta} - c)}{g_1 \bar{\beta}} + (1 - \tau)\left(f_1 t_1 - \frac{f_0 t_1 c}{g_1 \bar{\beta}}\right) \\
\implies \frac{c f_0}{f_1(\bar{\beta} - c)} &\leq \tau \qquad \text{(A1)}
\end{aligned}$$

Also, m^* must generate non-negative profits for a weak bureau. Thus,

$$\begin{aligned}
0 &\leq \tau(-\alpha_0^* c) + (1 - \tau)(f_1(t_1 - \alpha_1^* c) - f_0 \alpha_1^* c) \\
&\leq -\tau c t_1/\beta^* + (1 - \tau)(f_1 t_1 - f_0 c t_1/\beta^*) \\
&\leq -\tau c t_1/\bar{\beta} + (1 - \tau)(f_1 t_1 - f_0 c t_1/\bar{\beta}) \\
\implies \tau &\leq 1 - \frac{c}{f_1(\bar{\beta} + c)} \qquad \text{(A2)}
\end{aligned}$$

Combining (A1) and (A2) gives $\frac{f_0 c}{f_1(\bar{\beta} - c)} \leq 1 - \frac{c}{f_1(\bar{\beta} + c)} \implies \bar{\beta} \geq \frac{c}{f_1}(2 - f_1)$. Therefore, when $c/f_1 < \bar{\beta} < c(2 - f_1)/f_1$, a pooling equilibrium cannot exist. □

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