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Trading and Voting

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Abstract

Trading and Voting

The political choice between candidates with different redistribution policies plays out very differently in a complete financial market. When voters have the opportunity to trade election-contingent securities, we find that 1) wealth considerations have no effect on voting, so the interaction between candidates' redistribution policies and the distribution of wealth has no effect on who wins, 2) an election in which a candidate promises wealth redistribution results in redistribution of wealth, and the redistribution is the same regardless of who wins, and 3) if one candidate prefers some amount of redistribution and the other does not, the candidate who prefers redistribution will propose more redistribution than the amount he prefers. (*JEL* G33, D12, G21)

Elections assign the right to design tax policies, so to consumers they represent uncertainty over future wealth. An election pitting a candidate who proposes to redistribute wealth against another who does not indicates one future state of the world where the wealthy lose wealth to the poor, and another future state where they don't. One implication of this uncertainty is for the election's outcome: other things equal, a voter chooses the candidate delivering him more wealth, so the interaction of the tax policies with the wealth distribution decides who wins. The literature has explored this implication extensively (see, e.g., Myerson (1993), Persson and Tabellini (1994) and Lizzeri and Persico (2000)) including multi-period models focusing on accumulating debt (see, e.g., Lizzeri (1999) and Aghion and Bolton (1990)).

We are concerned here with a different implication, which turns out to have strong implications for the first: consumers would respond to the wealth uncertainty as they do to other financial risks, by trading financial instruments. If consumers can share the wealth risk by trading election-contingent securities (e.g. paying 1 if the redistributionist wins, 0 if he loses), the outcome of the political process is quite different on all the important dimensions. The probability of the redistributionist winning is different, the amount of redistribution is different, and the timing of the redistribution is different too.

The intuition for this result is that the potential for redistribution creates offsetting risks. The dollars that the wealthy lose to redistribution match the dollars the poor gain, so the enthusiasm of the wealthy for buying insurance againt the redistributionist winning resembles the enthusiasm of the poor for selling it. Equilibrium, we show, features full insurance; all consumers equalize wealth across the two states. This delivers both the result that wealth redistribution occurs before the election, rather than during or after, and also the result that wealth considerations do not determine who wins the election. With wealth the same whether or not the redistributionist wins, voters refer to their non-wealth preferences when making their choices. In other words, an externality of financial risk-sharing is that ideological, and not pocket-book, concerns decide who governs.

The rest of the paper is in three sections. Section 1 covers the relevant background. Section 2 describes, solves and interprets the model, Section 3 discusses some implications, and Section 4 summarizes and concludes.

1 Background

Consumers can vote themselves other people's wealth. A candidate can communicate that he would redistribute if elected, and a majority of votes makes it happen. This would seem to have serious implications for the distribution of wealth and the incentive to accumulate wealth in the first place.

When wealth is concentrated in a few voters, a candidate who favors redistribution would intuitively have an easy win over a candidate who doesn't, and wealth would accordingly even out.

Consider a two-candidate race. Two candidates communicate how they would govern, including how they would redistribute, then there's the vote, then the governing, including the redistribution. When the candidates' governing policies are endogenous, i.e. they communicate whatever policies they want to communicate, not just the policies that match their principles, the race becomes strategically interesting. If candidates just care about winning and not redistribution *per se*, they will espouse redistribution anyway, to buy votes (see, e.g., Myerson (1993)). Similarly, political parties with ideological motives are nonetheless motivated to buy votes with transfers (Dixit and Londregan (1996)). Throughout the extensive literature on this subject (see Drazen (2000) for a review), candidates' redistribution policies are viewed as key to electoral outcomes, being the major - or only - determinant of voters' preference orderings, and the candidates' policy choices are analyzed from this perspective.

Now consider the race from the consumers' point of view. The candidates partition the future into two possible states, one for each outcome, and each consumer expects more wealth in one state than the other. So the election creates uncertainty over future wealth, and there is an extensive literature on that subject, too. The standard analysis is that consumers have strictly concave utility for wealth, so they are all risk-averse at any wealth level, so they would prefer to hedge uncertainty over future wealth by trading financial securities.

The uncertainty caused by a potential redistribution is unusually well suited for such trade, for two reasons. First, if wealth is simply redistributed, rather than created or destroyed, then net redistribution is zero in each state. This suggests that the demand for securities that hedge against a candidate winning matches the supply. Second, the contingency that consumers want to hedge is easily verifiable, and therefore contractible.[1] And it is easy to come up with other financial securities, such as municipal bonds (and see "Presidential Race Induces Creation of Index Strategies" in the September 25, 2000 *Wall Street Journal*, and news reports between November 8 and December 13, 2000 for more ideas) with similar sensitivities to the electoral outcome.

To summarize, the existing literature on elections has not allowed for consumers' adaptive response to the uncertainty over wealth that potential redistribution represents, and the response indicated by the literature on financial securities is to hedge by trading. To see that this response is potentially crucial, consider a situation where consumers trade away all the risk, which is clearly possible since aggregate risk is zero. How would they vote? Anticipating that, how would they trade in the first place? And what does this imply for the redistribution of wealth? The next

[1] Consider, for example, the contracts traded on the Iowa Electronic Market.

section answers these questions with a simple but general model.

2 Model

2.1 The Setup

There are two dates, time 0 and time 1. There are two candidates, D and R, who announce at time 0 what they would do if elected at time 1. There are N consumers who can trade at time 0, and can vote and consume at time 1. What the consumers can trade are contracts that pay 1 if D wins, and 0 otherwise. They can buy or sell any amount of this contract. A candidate can propose a redistributive wealth tax which occurs immediately upon election. The tax applies to post-contract wealth: a consumer first pays or gets what his contract position dictates and then his resulting wealth is redistributed.

R communicates that he would govern with ideology $\mathcal{C}$ and impose no tax, and D communicates that he would govern with ideology $\mathcal{L}$ and impose a redistributive tax of τ (the method of communication is not modeled here; we take as given that voters learn that the candidates would enact these policies). The time t wealth of consumer c is w_c^t, and the utility of consumer c over time 1 (post-election, post-contract, post-redistribution) wealth and ideology $\mathcal{I}$ (i.e. the ideology of the winner) is

$$u_c(w_c^1) \ + \ v_c(\mathcal{I}),$$

where $u_c' > 0$, $u_c'' < 0$ and $v_c(\mathcal{C}) \neq v_c(\mathcal{L})$ for all c. The aggregate wealth of all consumers is known to be W, so per-capita wealth is known to be $W/N = \bar{w}$. The redistributive wealth tax collects τ of each consumer's wealth and distributes $1/N$ of the receipts to each consumer. So the net redistribution to a consumer with post-contract wealth w is $\tau(\bar{w} - w)$.

All consumers know the total wealth in the economy. Therefore, each consumer can calculate his wealth under both policies in period 1. Let $\boldsymbol{w^D} = (w_1^D, ..., w_N^D)$ and $\boldsymbol{w^R} = (w_1^R, ..., w_N^R)$ stand for period 1 wealth distribution. Similarly, $\boldsymbol{v} = (v_1, ..., v_N)$ denotes the ideological preferences. There is uncertainty about the collection of all consumers' ideology, $\boldsymbol{v}$, wealth distribution, $(\boldsymbol{w^D}, \boldsymbol{w^R})$, and identity of consumers. This uncertainty is represented by a finite set S of states. Consumers share a common prior about the true state of the world. Let ρ stand for this probability measure on S. Each consumer has private information in the sense that he knows at least his own ideological preference. This private information is described by $H_c : S \to 2^S$, a partitional information function. [Given the true state, $s \in S$, consumer c knows that true state could be any element of $H_c(s)$.] In addition, there is residual uncertainty over events that will affect the election outcome such as turnout, revelations about candidates' private lives, wars, recounts, and so on. Let $\rho(d, \boldsymbol{v}, \boldsymbol{w^D}, \boldsymbol{w^R})$ be the joint probability distribution describing this residual uncertainty given equilibrium behavior at the voting stage, where d is 1 if candidate D wins, 0 otherwise. Therefore, we can rule out any trivial setting: At period 0, no consumer can be sure about the outcome of the election independent of the amount of information he has, i.e., $0 < \rho(d = 1|\boldsymbol{v}, \boldsymbol{w^D}, \boldsymbol{w^R}) < 1$ for all $\boldsymbol{v}, \boldsymbol{w^D}$ and $\boldsymbol{w^R}$. For further use, let π stand for $\rho(d = 1|\boldsymbol{v}, \boldsymbol{w^D} = \boldsymbol{w^R})$. Finally, we assume that no consumer is negligible in determining the election outcome, for all $c \in \{1, ..., N\}$ and for all $s \in S$, we have $\rho(d = 1|H_{-c}(s), H_c(s)) \neq \rho(d = 1|H_{-c}(s))$ where $H_{-c}(s) \subseteq \{H_1(s), ..., H_{c-1}(s), H_{c+1}(s), ..., H_N(s)\}$.

2.2 Discussion of Modeling Choices

It would be simpler to solve a model with atomistic, and therefore price-taking, consumers.[2] But while that approximation is acceptable in some settings it is inappropriate here because it ruins the incentive to vote. That is, if a consumer's trading doesn't affect prices then his voting shouldn't affect the election. So we allow traders to move the market, in that the market price aggregates traders' information, though we do not explicitly model the trading mechanism. We solve for the equilibrium by first positing the existence of a price p^* at which there is no further trade, and then solving for p^*.

One potential concern with trading before voting is that the trading could reveal exactly who wins, so that the price goes to 0 or 1. To keep the focus on non-trivial trading outcomes we assume there is sufficient uncertainty over events intervening between trading and voting that the election's outcome can not be predicted exactly with information known at trading time. So we do not endogenize the timing of the trading relative to the arrival of election-relevant news, but it is intuitive that consumers would want to take their position in election-contingent securities *before* a given source of uncertainty taps out, not after.

We model utility over wealth as separable from utility over ideology. This is the same approach taken by Dixit and Londregan (1996). It is not hard to think of campaign positions that relate to both wealth and ideology, such as federal funding of abortions, or even redistribution itself. We are implicitly analyzing these positions as packages, combining wealth effects that affect consumers through u, and therefore interact with other wealth effects such as security payoffs, and ideological effects that are felt through v.

Finally, it is important to note that we are not modeling the relation between tax rates and real activity explored elsewhere in the literature (e.g., Meltzer and Richard (1981)). The tax in this model only redistributes wealth. As a flat wealth tax it is an approximation of federal taxes whose incidence generally increases with personal wealth. It is functionally equivalent to the linear

[2] In an earlier version, we show that our main results hold under a continuum of consumers/voters assumption.

income tax in Meltzer and Richard (1981), where voters start with no wealth.

2.3 Solving The Model

Let p^* be the equilibrium price of a contract. We first take it as given, then solve for it. If consumer c buys x_c contracts, then he pays $x_c p^*$ at time 0 and then gets x_c pre-tax in the state $\{D \text{ wins}\}$, and nothing in the state $\{R \text{ wins}\}$. The wealth he consumes in each state is therefore

$$w_c^0 - x_c p^* + x_c + \tau(\bar{w} - (w_c^0 - x_c p^* + x_c)) = \begin{array}{ll} \tau\bar{w} + (1-\tau)[(1-p^*)x_c + w_c^0] & \text{in } \{D \text{ wins}\}, \\ w_c^0 - x_c p^* & \text{in } \{R \text{ wins}\}. \end{array}$$

To calculate c's optimal contract position, we need the probability he puts the outcome $\{D \text{ wins}\}$, which for the moment we call Π_c. With this notation, c's problem is to choose the x_c that maximizes

$$\Pi_c[u_c(\tau\bar{w} + (1-\tau)((1-p^*)x_c + w_c^0)) + v_c(\mathcal{L})] + (1-\Pi_c)[u_c(w_c^0 - x_c p^*) + v_c(\mathcal{C})].$$

With w_c^D and w_c^R representing c's terminal wealth in $\{D \text{ wins}\}$ and $\{R \text{ wins}\}$, respectively, the first-order condition can be written

$$\Pi_c u_c'(w_c^D)(1-\tau)(1-p^*) = (1-\Pi_c)u_c'(w_c^R)p^*. \tag{1}$$

If $\Pi_c \neq 0$ and $p^* \neq 1$, this can be rewritten

$$\frac{u_c'(w_c^D)}{u_c'(w_c^R)} = \frac{(1-\Pi_c)p^*}{\Pi_c(1-\tau)(1-p^*)}. \tag{2}$$

We are now ready for the first results.

Proposition 2.1 *In the unique equilibrium, all consumers equalize wealth across the possible electoral outcomes and the outcome is determined solely by ideology, rather than the distribution of wealth. Furthermore, equilibrium is informationally efficient, i.e., the equilibrium price aggregates dispersed information in the economy perfectly.*

Proof : The proof of uniqueness is presented in the appendix. Here, we construct an informationally efficient Rational Expectations Equilibrium (REE). In an informationally efficient REE, the equilibrium price is a sufficient statistic for all private information. Therefore, Π_c is the same for all c. Assume for the moment that $0 < \Pi_c < 1$ and $0 < p^* < 1$. The RHS of (2) is the same for all c, so all consumers equalize $\frac{u_c'(w_c^D)}{u_c'(w_c^R)}$ to the same number. This number must be 1, because if it were greater than 1 then everybody would have more wealth in $\{R \text{ wins}\}$ than in $\{D \text{ wins}\}$, and this is not possible because aggregate wealth is the same in both states. Analogously, the number can not be less than 1. So it is 1, implying $w_c^D = w_c^R$ for all c.

With wealth equalized across outcomes, a consumer prefers the outcome $\{D \text{ wins}\}$ to $\{R \text{ wins}\}$ if and only if $v_c(\mathcal{L}) > v_c(\mathcal{C})$, so the probability of $\{D \text{ wins}\}$ is π, which by assumption is strictly between 0 and 1. This also implies that $0 < p^* < 1$, because if $p^* = 1$ everyone would be better off selling more contracts, and if $p^* = 0$ everyone would be better off buying more. Market clearance follows immediately from Lemma 2.2. ∎

The equilibrium contract price is easily inferred:

Lemma 2.1 *The price per contract p^* is $\frac{\pi - \pi\tau}{1 - \pi\tau}$.*

Proof: Set the RHS of (2) equal to 1 and solve for p^*. ∎

Note that p^* is always less than π for $\tau > 0$. We can also solve for the number of contracts purchased:

Lemma 2.2 *Consumer c buys $x_c = \tau(\frac{1-\pi\tau}{1-\tau})(w_c^0 - \bar{w})$ contracts.*

Proof: Set $w_D = w_R$, plug in the equilibrium value of p^* and solve for x_c. ∎

This can also be written $x_c = (\frac{\tau\pi}{p^*})(w_c^0 - \bar{w})$, which leads to our next major result:

Proposition 2.2 *When consumers trade before voting, the wealth redistribution occurs before the election, is unrelated to the outcome, and is the product of the probability of the redistributionist winning when votes depend only on ideology and the redistribution that would have occured without trading if the redistributionist won.*

Proof: In both states, wealth equals $w_c^0 - x_c p^*$, which is $w_c^0 - (\frac{\tau\pi}{p^*})(w_c^0 - \bar{w})p^*$, or $w_c^0 + \pi\tau(\bar{w} - w_c^0)$. So the wealth redistribution is $\pi\tau(\bar{w} - w_c^0)$ regardless of who wins, and this is π times the redistribution that would have occured in $\{D \text{ wins}\}$ without trading. ∎

This is a big departure from the standard economic analysis of elections. When consumers can trade before voting, the wealth effect of a candidate's redistribution plan no longer affects his chances of winning, but it does affect the resulting redistribution whether or not he wins. The magnitude of the effect depends on his chances of winning, but his chances of winning depend solely on his ideological appeal. Consumers can trade wealth but not ideology across states, and this is what happens.

Because it affects the state probabilities, the trade in election-contingent securities is not simply Pareto-improving risk sharing. Poor people could view it as a coordination problem. The redistributionist might have been an almost sure thing if wealth distribution influenced voting, but not with wealth equalized, so the net effect for consumer c goes from close to $\tau(w_c^0 - \bar{w})$ to $\pi\tau(w_c^0 - \bar{w})$. This is an adverse development if $w_c^0 < \bar{w}$, but the consumer is better off trading than not even though he would be best off if nobody traded.

3 Discussion

The effect of financial securities on the voting equilibrium extends to several important economic issues. This section briefly outlines some of the implications.

3.1 Median Voter Theorem

The Median Voter Theorem (Black (1948)) finds a special role for the preferences of the median voter. If policies differ on a single dimension and voters' policy preferences are single-peaked, the equilibrium outcome of majority voting is the policy preferred by the median voter. Our results warn against extending this logic to redistribution policies. The redistribution policy chosen by majority voting does not relate to the distribution of its impact on voters' wealth. Its only impact is through voters' ideological preferences regarding redistribution. Notice also that we could have imposed a super-majority rule and the same results would have obtained.

It is tempting to recast the model as a one-dimensional vote on redistribution by removing the ideological dimension. This is similar to the Black (1948) framework, except with trading. But while this simplifies the model it creates the new problem that if voters have preferences only over wealth and their wealth is not exposed (after trading) to the election's outcome, then nobody has any incentive to vote. If we add the assumption that they vote anyway, with some mixing strategy over equivalent choices, then the result is that trading completely disconnects the equilibrium policy choice from the distribution of preferences when the policy is redistribution and preferences are only over wealth. We could call the result the Average Voter Theorem, in that trading causes all voters to share the preference-ordering of the average (i.e. average wealth) voter, to whom redistribution is a wash with or without trading. The reader can confirm that our argument also goes through for lump-sum transfers, such as those in Myerson (1993).

3.2 Strategic Policy Choices

So far we have not specified a set of preferences for the candidates, but rather taken their policy choices as given and analyzed the consumers' reaction. However, if candidates care about the enacted policies (both ideological and redistributive) they will behave strategically in announcing their policy choices. Maximizing expected utility, each candidate must consider a policy's electability as well as its desirability. Assume that candidates can commit to policies. At the time candidates announce policies they know the election will depend solely on $\boldsymbol{v}$ due to backward induction. Consequently, the candidates may have to announce more moderate ideological policies in order to increase the probability of winning and maximize expected utility. On the other hand, the choice of tax rate will have no effect on the outcome of the election. However, we have shown that the tax rate will affect the wealth distribution independently of who wins, and the effect is the product of the probability of the redistributionist winning when votes depend only on ideology and the redistribution that would have occured without trading if the redistributionist won. Therefore, to cause the redistribution that tax rate τ causes in the absence of trading, candidate D commits to a tax rate *higher* than τ, i.e. τ divided by his probability of winning based on ideology (and note that D must actually impose this higher tax rate if elected to cause the desired net redistribution).

Proposition 3.1 *When candidates choose their policies strategically, candidate D chooses a tax rate that causes more gross redistribution than the amount of net redistribution that D prefers or expects.*

3.3 Economic Efficiency

Much of the literature on redistribution addresses the interaction between tax policies and real activity. Without completely overhauling the model to endogenize wealth creation, we can still make the simple point that trading increases the probability that an election chooses the higher-wealth outcome. Let

$$\frac{u_c'(w_c^D)}{u_c'(w_c^R)} = \frac{(1-\Pi_c)p^*}{\Pi_c(1-\tau)(1-p^*)} = k,$$

where Π_c is equal across c. When total wealth is equal across states, k has to be one. But suppose instead that total wealth is lower when D wins. In that state, some amount of wealth burns up. Then k must be greater than one in equilibrium, since it can not be equal to or less than one. Therefore, *everybody* gets more wealth in $\{R$ wins$\}$, biasing the outcome toward $\{R$ wins$\}$. So the wealth effect on the election outcome is strictly in the direction of the higher-wealth state, though the magnitude of this effect depends on the relative strength of ideological preferences.

4 Summary and Conclusion

An election creates wealth risk, and a securities market reallocates wealth risk. The wealth risk created by an election is just the kind for securities-trading to reallocate, because demand naturally equals supply. The result of trading is a transformed election, with wealth-considerations separated completely from voting decisions, and redistribution separated completely from the election's outcome. Our propositions constitute a baseline case for arguments that redistribution buys votes, or that the amount of redistribution depends on the election's outcome. For those arguments to go through, there must be some departure from our assumptions, such as transactions costs, incomplete markets, or endogenous wealth creation.

One perspective on the results here is that consumers' financial exposures to an election have qualitatively different implications for the outcome and net effect of the election than do their other exposures. Financial exposure can be traded across states, and risk-aversion encourages this trade. So elections determine wealth redistribution differently from the way they determine other policies at stake, raising the question as to whether they are equally efficient at resolving distributional and ideological disputes.

A Appendix

In this section, we will first define the equilibrium concept and recall the definition of common knowledge. Second we will prove the uniqueness of equilibrium.

Definition A.1 *Price $p^*(H_1(s), ..., H_N(s))$ is an equilibrium if*

1. *At $t = 1$, each consumer votes to maximize his expected utility given his post election wealth, w_c^1 and ideology, $v_c(.)$.*
2. *At $t = 0$, each consumer chooses his demand $x_c(p, H_c(s))$ to maximize expected utility assuming that the probability Π_c is given by $f(d = 1|p = p^*, H_c(s))$, where $f(d = 1, p^*, H_1(s), ..., H_N(s))$ is the true joint probability distribution given $p^*(H_1(s), ..., H_N(s))$ and optimal voting at $t = 1$.*
3. *Given consumers' demands, $p^*(H_1(s), ..., H_N(s))$ is market clearing for all realizations of consumers' private information.*

Definition A.2 *An event $F \subseteq S$ is* self-evident *between consumers c and c' if for all $s \in F$ we have $H_c(s)$, $H_{c'}(s) \subseteq F$. An event $E \subseteq S$ is* common knowledge *between consumers c and c' in state s if there is a self-evident event F for which $s \in F \subseteq E$.*

Lemma A.1 *There exists a unique equilibrium.*

Proof :

We prove our claim in two steps. First, we show that the full information economy has a unique equilibrium. This result implies that there can be at most 1 informationally efficient REE. Second, we show that there are no partially or non-revealing REE.

In a full information economy, Π_c is the same for all consumers. Furthermore, Π_c is strictly between 0 and 1 by the residual uncertainty assumption. Therefore, Equation (2) must hold for every equilibrium of the full information economy. However, this implies the equilibrium characterized by Proposition 2.1. This concludes the first step.

Now we proceed with the second step that there are no partially or non-revealing REE. Suppose not. Then there is an equilibrium price p' that is not informationally efficient. Equation (2) must hold for this equilibrium as well given the residual uncertainty assumption. If each consumer has equalized wealth across states, $\boldsymbol{w^D} = \boldsymbol{w^R}$, then $\frac{(1-\Pi_c)p'}{\Pi_c(1-\tau)(1-p')} = 1$ for all c. This implies that $\Pi_c = \frac{p'}{(1-\tau)(1-p')+p'}$ for all c. However, Π_c cannot be the same for all c given that at least one consumer has private information. Therefore, the only possibility left is $\frac{(1-\Pi_c)p'}{\Pi_c(1-\tau)(1-p')} \neq 1$ for at least one consumer. Therefore, there exists at least one consumer, say c who has not equalized wealth across states. Without loss of generality, assume that this consumer has more wealth if D wins. From the market clearance condition there must exist another consumer, say c', who has more wealth if R wins. Therefore, $\frac{u'_c(w_c^D)}{u'_c(w_c^R)} < \frac{u'_{c'}(w_{c'}^D)}{u'_{c'}(w_{c'}^R)}$. Consequently, from Equation (2), we must have $\Pi_c > \Pi_{c'}$, i.e., $\rho(d=1|H_c(s)) > \rho(d=1|H_{c'}(s))$. Market clearance also implies that this inequality is common knowledge among these two consumers. [Equivalently, we say event $E = \{s \in S | \rho(d=1|H_c(s)) > \rho(d=1|H_{c'}(s))\}$ is common knowledge.] In the rest of the proof we will show that common knowledge of such a disagreement cannot occur in equilibrium. Given that the event $\rho(d=1|H_c(s)) > \rho(d=1|H_{c'}(s))$ is common knowledge, there must be an event $F \ni s$ that is a subset of E and is a union of members of the information partitions of both consumers, i.e., $\bigcup_{s\in F}(H_c(s) \cup H_{c'}(s)) = F \subseteq E$. Given that $\rho(d=1|H_c(s)) > \rho(d=1|H_{c'}(s))$ is common knowledge for all $s \in F$, this inequality $\rho(d=1|H_c(s)) > \rho(d=1|H_{c'}(s))$ must hold for all $s \in F$. Therefore, we have

$$\sum_{s\in F} \rho(s)\rho(d=1|H_c(s)) > \sum_{s\in F} \rho(s)\rho(d=1|H_{c'}(s)).$$

But since F is a union of members of each consumer's information partition both sides of this inequality are equal to $\rho(F)\rho(d=1|F)$. However, this contradicts the above inequality and concludes the second part of the proof. Therefore, neither partially nor non-revealing equilibria can exist. ∎

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