THE POLITICAL ECONOMY OF PRICE SUPPORTS

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for Jenny, Mychal, and Conchita

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Ed Campos

May 1987

ABSTRACT

Economic analyses of public policy typically focus on the detrimental effects of market failure. Because of inherent imperfections, a market may not function properly. Government is then called upon to rectify the situation. Implicit in this argument is that government intervention generates a net social gain; the gainers from the intervention can, in principle, compensate the losers.

Proponents of U.S. agricultural price support policies often adopt this perspective. Recent studies, however, have cast some doubt on this argument. If anything, they suggest that such policies have generated net social losses.

If agricultural price support policies do not benefit society, why, then,do they exist? Political scientists provide some insight into this matter. The electoral objectives together with certain Congressional institutions such as the committee/subcommittee system facilitate the passage of legislation that confers benefits to narrow interests while distributing the costs over larger, less organized interests. Political models, however, do not identify the underlying economic factors which define feasible policy outcomes.

Some nontraditional economic models, notably those of Stigler, Peltzman, and Becker, do address the connection between economic conditions and policy outcomes. But these models are stripped of relevant political insitutions. Consequently, like their political science counterparts, they fail to completely describe the mapping from political preferences and economic phenomena onto policy outcomes. In short, neither class of models provides an adequate explanation for the existence of price supports.

In this manuscript, I develop a formal political economy model of price supports that incorporates the interaction of economic forces, organizational costs, electoral objectives, and Congressional institutions in the enactment of price support legislation. My efforts are an

attempt to utilize certain aspects of microeconomic theory and political theory to construct a positive theory of agricultural price supports. Most studies have concentrated mainly on the welfare (normative) aspects of price support policies. Some have dealt with the political foundations but they fail to consider the normative implications. But who gains and who loses, and the extent and the distribution of the gains and losses, have a great deal to do with the final outcome. This inadequacy, I believe, derives from the absence of an analytical model within which the interaction of the economics and the politics of price support policies can be studied.

A regulatory policy can be implemented in various ways. But for the most part, political scientists and economists have ignored or downplayed this characteristic. Consequently, their models do not have much predictive power. They cannot say much about the nature of a particular regulatory policy.

Different instruments have been used to support prices of agricultural commodities (in the U.S.). Support programs have varied both across commodities and over time for a particular commodity. I expand my formal model to make it suitable for studying the implicit choice process.

I use the model to generate two sets of hypotheses. The first set involves propositions pertaining to the relationship between selected exogenous economic and political variables and the level of price supports. The second set involves propositions pertaining to the relationship between a slightly different set of political and economic variables and the choice of method used to support prices. I test the hypotheses econometrically against data from selected U.S. agricultural markets.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

My dissertation is motivated by a desire to integrate economics and political science. It stems from a realization that integration could lead to a better understanding of many phenomena that cannot be adequately explained by either economics or political science alone. One such phenomenon is the existence of inefficient policies, in particular, regulatory policies. Both political scientists and economists have studied this matter and have proposed possible explanations. But, with few exceptions, each group fails to transcend the barriers defined by its respective field: political scientists provide political analyses and economists economic analyses. Consequently, each presents only a partial view of the matter and gives inadequate policy prescriptions. Hence, a fuller grasp of this phenomenon, particularly the relationships among political preferences, economic factors, decision-making processes, and policy outcomes, is needed. But this can be achieved only through an interdisciplinary analysis.

A closely related phenomenon is the choice of method in regulating a market. This is generally referred to as the problem of instrument choice. Given a market is to be regulated, how is the regulation to be implemented? Why is the regulation implemented differently across markets? Why does the character of the regulation change over time? These are questions that political scientists and economists have not addressed to any significant degree. But a cursory look at any regulatory policy is enough to convince one of its relevance and importance. Again, an interdisciplinary analysis provides a better grasp of the problem.

Agricultural policy (U.S.) is a fertile ground for studying the two phenomena. The policy revolves fundamentally around price supports for select agricultural commodities. Studies have shown that price support programs have not been beneficial to society (Wallace, 1962; Johnson, 1973; Heien, 1977; and Gardner, 1981), and that they vary considerably both across commodities and over time (Paarlberg, 1964; Johnson, 1973; Cochrane and Ryan, 1976). If such programs yield inefficiencies, then why do they exist? Why do we observe significant variation in the types of programs implemented? My dissertation represents an attempt to explain the existence of price supports (in the United States) and to provide a foundation for a theory of instrument choice within a political economy framework.

The manuscript is divided into three parts. Chapters one through four deal with the existence problem and chapters six and seven with the instrument choice problem. Chapter five provides a transition from the existence to the instrument choice problem.

In the first chapter, I present the basic explanation forwarded by economists to rationalize the use of price supports—price stabilization at the mean. I argue that the kinds of price support programs one observes in the real world differ fundamentally from the price stabilization scheme assumed by economists—they necessarily make consumers worse-off. Thus, one must look elsewhere for an explanation, in particular at political science models.

There exist "purely" political models of stable policy outcomes. Political scientists have used these models to rationalize the existence of inefficient policies. In the second chapter, I discuss and criticize two such models: the Shepsle model and models which defend equilibrium outcomes through the adoption of norms. I argue that both are deficient. First, they do not identify the underlying economic factors that determine political preferences and thus policy outcomes. And second, they assume radical relationships among legislators; the Shepsle model assumes a mutually hostile relationship between members and nonmembers of any given committee within a legislature, while the latter class of models assume relationships are completely fluid. This departs significantly from the actual workings of Congress. In the third chapter, I address this deficiency by amending the Shepsle model to accommodate bargaining between committee and noncommittee members. Specifically, I identify conditions that make some bargaining possible within a Shepsle framework.

The fourth chapter focuses on the construction and testing of a model that is in theory better suited for studying the existence of price support programs. The model is based on the fundamental structure implicit in both the Shepsle model and the norm based models.

In the first section of the chapter, I create a political structure within which legislative decisions are made and link it with the underlying economic factors involved in evaluating the effect of price supports. I assume that decisions are made by a legislative body whose members are elected representatives from districts that make up the country. Election is by majority rule and each member's basic objective is to get reelected. I assume the body is decomposed into committees which in turn are divided into subcommittees; each committee is assigned a major legislative area—one of which is price supports—and each subcommittee therein specializes in a certain aspect of the assigned area. I further assume that the assignment process is such that members of a subcommittee are precisely those who come from districts whose constituents could benefit from favorable legislation under the jurisdiction of the subcommittee. To link this structure with economic factors, I construct a preference function for an arbitrary member that is based on the economic gains and losses associated with an effective price support and the composition of his constituency: a price support above the free market level results in gains to producers and losses to consumers so that the electoral chances of each member depends in part on the outcome of price support legislation. Note that the gains and losses are derived from demand and supply which, in turn, are derived from individuals' preferences over commodities and firms' production functions. Thus, the model ultimately links basic economic factors with the political structure. In the latter part of the chapter, I show that the preferences of legislators as determined by economic gains and losses and the composition of their constituencies combined with the assumed political structure make possible the existence of price supports. This result depends in part on some form of bargaining between committee and noncommittee members such as the one described in the third chapter.

In the second section, I do some comparative statics to establish predictions that the model makes regarding the response of price support levels to changes in economic and political parameters. Specifically, I look at the impact of technological improvement, the effect of input restrictions, changes in the composition of a given district, and a change in the cohesiveness of producers as a group. In the last section, I then look at some empirical evidence. Specifically, I test the predictions against data from the U.S. feed grains markets.

There are some nontraditional economic models that provide alternative analyses of the existence problem. But unlike the political models, they can or do deal with the instrument choice problem. Prominent among these are the Stigler/Peltzman and the Becker models. In chapter five I summarize and critique these models. Basically, I argue that the models are institution deficient. Consequently, like the political models, they cannot provide an accurate mapping from political preferences onto policy outcomes and instrument choice.

In chapter six, I extend my model to address the instrument choice problem. I develop a theory of choice for an individual legislator and use it to study the choice among production control methods associated with price support programs. Methods range from literally no restrictions—a pure price floor above the free market price—to severe restrictions—a production quota. I state and prove propositions that identify conditions that determine a legislator's choice. I show that, under certain conditions, a production quota will prevail over a pure price floor. In particular, if demand for the supported commodity is sufficiently inelastic, or supply is sufficiently elastic at equilibrium, then a legislator will choose the latter, but if demand were sufficiently elastic or supply sufficiently inelastic, then he would choose the former. I also show that if input restrictions were imposed in conjunction with a price floor, then a legislator may favor a price floor over a production quota. Finally, I perform some comparative static exercises to depict how the choice might change in response to changes in certain economic and political parameters: technological change, a rise in the cost of maintaining the surplus generated by a price support program, a rise in the magnitude of the surplus, a decline in the number of rural Congressional districts relative to metropolitan districts, and a change in the cohesiveness of producers and consumers.

To support the instrument choice predictions of the model, I devote the seventh chapter to an empirical analysis of eight agricultural markets where price supports have long existed, namely, wheat, corn, grain sorghum, barley, oats, cotton, tobacco, and rice. Specifically, I list and explain each of the instruments that had been or were used to support prices in these markets during the period 1953 to 1972. I then use an ordered probit (econometric) model to test hypotheses about the choice among various production control methods. To facilitate the interpretation of the results, I give a brief explanation of an ordered probit model.

CHAPTER 1

THE NONOPTIMALITY OF PRICE SUPPORTS

A price support represents a form of interference in the market. If the demand for and the supply of a commodity are stable (more precisely, nonrandom), then a price support above the free market equilibrium would necessarily generate inefficiencies. Hence, as early as 1940, economists have attempted to rationalize price supports as a means of stabilizing price, which under certain conditions would benefit both producers and consumers. But, as I argue below, the schemes they assume are inconsistent with real world price support programs.

Massell (1969) established conditions under which producers and consumers of a given commodity would benefit from the stabilization of the commodity's price at its expected value. In 1980, Turnovsky, Shalit, and Schmitz "modernized" Massell's arguments. They used the indirect utility function to determine the conditions required for a consumer to benefit from this kind of price stabilization scheme. Implicit in their analysis is that the producer always benefits from price stabilization; as I argue below, this is generally the case. Many others have discussed the benefits of this scheme. However, I will limit my discussion to the Turnovsky/Shalit/Schmitz argument since it is the most straightforward.

A. Price Controls and the Consumer:

Turnovsky/Shalit/Schmitz introduce an the indirect utility function $v(p_1,..,p_n;m)$. By Roy's identity,

$$x_i = -\frac{(\partial v/\partial p_i)}{(\partial v/\partial m)} \quad \text{for all} \quad i = 1, \ldots, n . \tag{1.1}$$

Letting $\lambda = (\partial v/\partial m)$ and differentiating (1.1) with respect to m yields,

$$\frac{\partial^2 v}{\partial m \, \partial p_i} = -\left[\lambda \frac{\partial x_i}{\partial m} + x_i \frac{\partial \lambda}{\partial m}\right] \quad \text{for all} \quad i . \tag{1.2}$$

For definiteness, let commodity 1 be the commodity whose price is to be stabilized and let $\bar{p}_1 = E(p_1)$. Then, a consumer will benefit (lose) from stabilization at $\bar{p}_1$ if and only if,

$$EV(p_1, \ldots, p_n; m) < (>)\, V(\bar{p}_1, \ldots, p_n; m) \tag{1.3}$$

or equivalently,

$$V \text{ is strictly concave (convex) in } p : \frac{\partial^2 v}{\partial p_1^2} < (>)\, 0 . \tag{1.3'}$$

Figures 1.1 and 1.2 illustrate this for the simple price distribution,

$$p_1 = \begin{cases} p_1^0 , & \\ p_1' , & \text{with probability } .5 \end{cases}$$

If V is strictly concave then $EV(p_1, \cdot) < V(\bar{p}_1, \cdot)$ and if it is strictly convex then $EV(p_1, \cdot) > V(\bar{p}_1, \cdot)$.

Now from (1.1),

$$\frac{\partial(\lambda x_1)}{\partial p_1} = \lambda \frac{\partial x_1}{\partial p_1} + x_1 \frac{\partial \lambda}{\partial p_1} = - \frac{\partial^2 v}{\partial p_1^2}$$

or,

$$\frac{\partial^2 v}{\partial p_1^2} = - \left[\lambda \frac{\partial x_1}{\partial p_1} + x_1 \frac{\partial \lambda}{\partial p_1} \right] . \tag{1.4}$$

Substituting (1.2) into (1.4),

$$\begin{aligned} \frac{\partial^2 v}{\partial p_1^2} &= - \frac{\partial v}{\partial m} \cdot \frac{\partial x_1}{\partial p_1} + x_1 \left[\frac{\partial v}{\partial m} \cdot \frac{\partial x_1}{\partial m} + x_1 \frac{\partial^2 v}{\partial m^2} \right] \\ &= \frac{\partial v}{\partial m} \left[x_1 \frac{\partial x_1}{\partial m} - \frac{\partial x_1}{\partial p_1} \right] + x_1^2 \frac{\partial^2 v}{\partial m^2} \\ & \left[\frac{x_1(\partial v/\partial m)}{p_1} \right] \left[p_1 \frac{\partial x_1}{\partial m} - \frac{p_1}{x_1} \frac{\partial x_1}{\partial p_1} + (p_1 x_1) \cdot \frac{(\partial^2 v/\partial m^2)}{(\partial v/\partial m)} \right] \\ & \left[\frac{x_1(\partial v/\partial m)}{p_1} \right] \left[\left[\frac{p_1 x_1}{m} \right] \left[\frac{m}{x_1} \frac{\partial x_1}{\partial m} + \frac{(\partial^2 v/\partial m^2)}{(\partial v/\partial m\ )} \cdot m \right] - \frac{p_1}{x_1} \frac{\partial x_1}{\partial p_1} \right] . \end{aligned} \tag{1.5}$$

Let $e = (\partial x_1/\partial p_1)(p_1/x_1)$, $\eta_1 = (\partial x_1/\partial m)(m/x_1)$, $s_1 = (p_1 x_1/m)$, and $\rho = -[(\partial^2 v/\partial m^2)/(\partial v/\partial m)]$, then

$$\frac{\partial^2 v}{\partial p_1^2} = \left[\frac{x_1(\partial v/\partial m)}{p_1} \right] (s_1(\eta_1 - \rho) - e_1) . \tag{1.6}$$

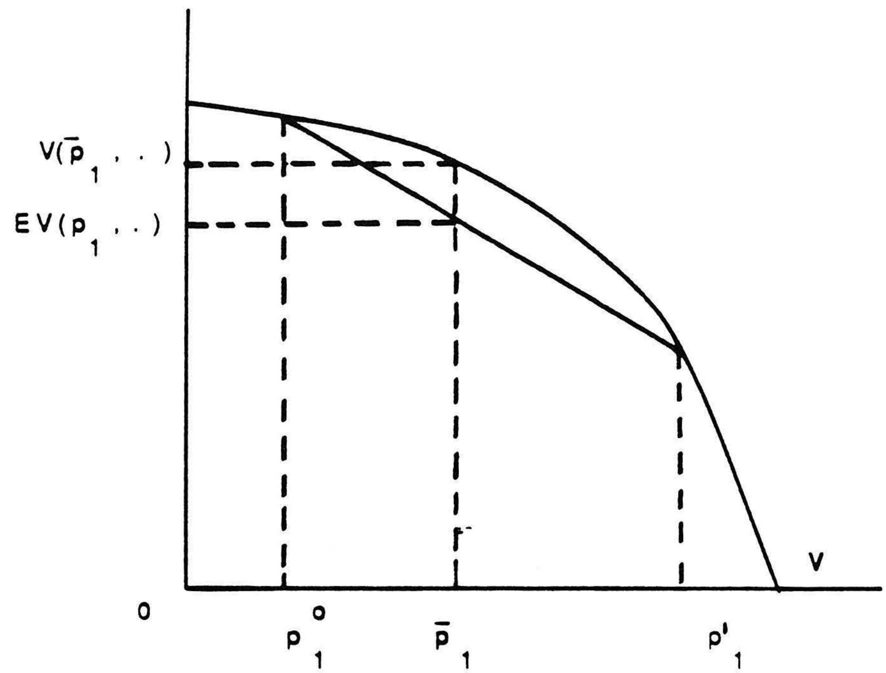


FIGURE 1.1 a

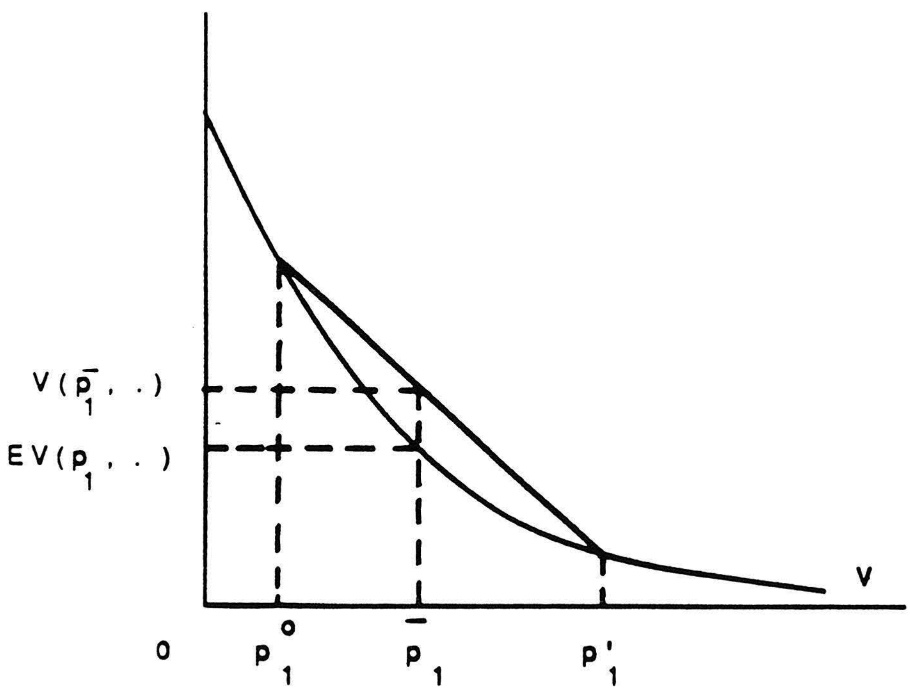


FIGURE 1.1 b

Note that ρ is the Pratt/Arrow index of relative risk aversion, e_1 the consumer's own direct price elasticity of demand for commodity 1, η_1 the consumer's income elasticity for commodity 1, and s_1 the commodity's share in the consumer's budget. Now the Slutsky equation implies,

$$e_1 = \frac{p_1}{x_1} \cdot \frac{\partial x_1}{\partial p_1} - \frac{p_1}{x_1}\left[\frac{\partial x_1}{\partial p_1}\Big|_{\bar{u}} - x_1\frac{\partial x_1}{\partial m}\right] = e_1^c - p_1\frac{\partial x_1}{\partial m}$$

where $\frac{\partial x_1}{\partial p_1}\Big|_{\bar{u}}$ is the slope of the compensated demand function and $e_1^c = \left[\frac{\partial x_1}{\partial p_1}\Big|_{\bar{u}}\right](p_1/x_1)$.

Hence,

$$\begin{aligned}(s_1(\eta_1 - \rho) - e_1) &= (p_1x_1/m)(\eta_1 - \rho) - (e_1^c - p_1(\partial x_1/\partial m))\\ &= (p_1x_1/m)(\eta_1 - \rho + (m/x_1)(\partial x_1/\partial m) - e_1^c)\\ &= s_1(2\eta_1 - \rho) - e_1^c\ .\end{aligned}$$

Since x_1, p_1, and $(\partial v/\partial m)$ are positive, then, from (1.6), $sign(\frac{\partial^2 v}{\partial p_1^2}) = sign(s_1(2\eta_1 - \rho) - e_1^c)$. Now since e_1^c is always negative, then the consumer will benefit from price stabilization only if $(2\eta_1 - \rho)$ is negative, i.e., the consumer's relative risk aversion index must always be greater than twice his income elasticity for commodity 1. Note also that if $(2\eta_1 - \rho)$ were positive, then the consumer will be worseoff under stabilization.

B. Price Controls and the Producer:

In analyzing the decision making process of a producer under uncertainty, economists often assume that the producer is some risk-neutral firm that maximizes its expected profit. In some cases, though, the producer is not some big, impersonal entity. A farmer, for example, is not; his profit is generally his main source of income and therefore figures prominently in his decision calculus as a consumer. A price stabilization scheme involving the commodity he produces affects his utility primarily through his income.

Assume for simplicity that a producer of commodity 1 provides for his own consumption of the commodity, e.g., a dairy farmer provides his own milk. Then his indirect utility function is of the form $V(p_2, \ldots, p_n; m(\cdot))$ where $m(\cdot) = p_1 q_1(\cdot) - c(q_1(p_1))$, $q_1(\cdot)$ his supply function, and $c(\cdot)$ his cost function. Now differentiating $m(\cdot)$ once yields,

$$m' = p_1 q_1' + q_1 - c' q_1' = (p_1 - c')\, q_1' + q_1 = q_1 > 0 \tag{1.7}$$

and twice,

$$\begin{aligned} m'' &= p_1 q_1'' + 2q_1' - (c' q_1'' + c''(q_1')^2) \\ &= (p_1 - c') q_1'' + 2q_1' - c''(q_1')^2 \\ &= q_1'(2 - c'' q_1'). \end{aligned} \tag{1.8}$$

The producer will gain from price stabilization if and only if,

$$EV(p_2, \ldots, p_n; m(p_1)) < V(p_2, \ldots, p_n; m(\bar{p}_1)) \tag{1.9}$$

or, as above, if and only if V is strictly concave in p_1. Now $(\partial v / \partial p_1) = (\partial v / \partial m) m'$ and

$$\frac{\partial^2 v}{\partial p_1^2} = \frac{\partial v}{\partial m} m'' + \left[\frac{\partial^2 v}{\partial m^2} \right] (m')^2 \tag{1.10}$$

which is negative if and only if

$$(m'' / (m')^2) < - \frac{(\partial^2 v / \partial m^2)}{(\partial v / \partial m)} . \tag{1.11}$$

Upon substituting (1.7) and (1.8) into (1.11), one gets

$$q_1'(2 - c'' q_1') < - \frac{(\partial^2 v / \partial m^2)}{(\partial v / \partial m)} . \tag{1.11$'$}$$

Multiplying both sides of (1.11′) by $(p_1 \cdot q_1)$ results in,

$$\left[\frac{p_1}{q_1} \cdot q_1' \right] (2 - c'' q_1') < - \frac{(\partial^2 v / \partial m^2)}{(\partial v / \partial m)} (p_1 q_1) = - \frac{(\partial^2 v / \partial m^2)}{(\partial v / \partial m)} (m + c(q_1)) . \tag{1.12}$$

Assuming the producer is risk averse then $(\partial^2 v / \partial m^2) / (\partial v / \partial m)$ is negative and so $[-\{(\partial^2 v / \partial m^2) / (\partial v / \partial m)\} m]$ is the Pratt/Arrow index of relative risk aversion. Note also that $[(p_1 / q_1) q_1')]$ is the supply elasticity of commodity 1. Denoting this ξ, (1.12) is equivalent to,

$$\xi(2 - c''q_1') < \rho(1 + [c(q_1)/m]) \tag{1.13}$$

or, since $c(q_1) = p_1q_1 - m$,

$$\xi(2 - c''q_1') < \rho([p_1q_1]/m) . \tag{1.13'}$$

Since $(2 - c''q_1')$ is almost always negative then (1.13′) is generally satisfied. That is, the producer generally benefits from price stabilization at the mean.

C. Real versus Theoretical Schemes:

The preceding arguments are based on the assumption that price is stabilized at its mean. The government introduces measures to keep it from rising or falling. However, this is not the kind of price support scheme that one observes in the real world. Such schemes generally keep price from falling below a certain predetermined level but do little or nothing to keep it from rising. This necessarily makes consumers worseoff. By cutting off the lower end of the price distribution, such schemes deprive consumers of low prices and occasionally make them pay high prices. This point can be proven more rigorously.

Let $V(p_0, p; m)$ be the indirect utility function of the consumer, where p is the price of the supported commodity, m his money income, and p_0 a price vector of all other commodities. Let $f(p)$ be the density of the price p with support at $[p_L, p_u]$. Then, in the absence of a price support program, the consumer's expected utility is,

$$E(V) = \int_{p_L}^{p_u} V(p_0, p; m) f(p) dp .$$

If a price support program with cutoff point at p is implemented, then his expected utility would be,

$$E(V) = \int_{\bar{p}}^{p_u} V(p_0, p; m) f(p) dp + V(p_0, \bar{p}; m - t(\bar{p})) \int_{p_L}^{p_u} f(p) dp$$

where $t(p)$ is the tax the government collects from him to maintain the support program. Now,

$$E(V) = \int_{p_L}^{\bar{p}} V(p_0, p; m) f(p) dp + \int_{\bar{p}}^{p_u} V(p_0, p; m) f(p) dp .$$

Clearly, since $V(p_0, p; m)$ is greater than or equal to $V(p_0, \bar{p}; m - t(\bar{p}))$ for all $p \in [p_L, p_u]$ then,

$$\int_{p_L}^{\bar{p}} V(p_0, p; m) f(p) dp > V(p_0, \bar{p}; m - t(\bar{p})) \int_{p_L}^{\bar{p}} f(p) dp .$$

Hence, $E(V) > \tilde{E}(V)$, i.e., the consumer is worseoff under the program.

A price support policy that is designed to stabilize prices in order to make both consumers and producers betteroff must necessarily chop off the price distribution at both ends of the spectrum. This, in fact, is the main idea behind the theoretical price stabilization schemes discussed earlier. And, once again, these are not the kinds of schemes we observe. Thus, real world price support policies cannot be rationalized on strict economic grounds. But how, then, can one explain their existence? This is the puzzle I attempt to solve in part two of this manuscript.

PART I

ON THE EXISTENCE OF PRICE SUPPORTS

CHAPTER 2

THE EXISTENCE PROBLEM AND RELEVANT POLITICAL MODELS

Political scientists have developed models to try to explain observable phenomena that cannot be justified strictly on economic grounds—in particular the existence of price supports. In this chapter I will give a synopsis of two fundamental classes of models relevant to the existence problem: the Shepsle-based models and the norm-based models. I will then point out their weaknesses and argue why a better model needs to be developed.

The ultimate goal of a congressman (or senator for that matter) is to get re-elected. To do this, he needs to maintain the continued support of his constituents. To get and keep their support, he has to use his influence within Congress to persuade bureaucrats to provide them with material benefits and/or services. Bureaucrats, on the other hand, desire (or at least are assumed to desire) budget security. To attaining this objective, they accommodate the requests of legislators particularly those who can exercise significant influence on the size of their budgets. Accommodation often means doing a congressman's (or senator's) constituents a service or providing them with some particularized benefit. Figure 2.1 summarizes this legislator-constituency-federal agency relationship. Given the nature of this relationship, it is not surprising that incumbents remain in Congress for many terms, and that membership in the various Congressional committees has remained relatively stable over time. Indeed, this is the thrust of Fiorina's (1978) rationale for the vanishing marginals. Congressmen have gradually switched emphasis in strategies from a predominantly policy-making to a predominantly pork barrel/casework approach. Consequently, given the goals of bureaucrats and constituents, an incumbent more often than not gets re-elected.

The net result of this institutionalized relationship is, first of all, a tendency to focus bills that generate particularized benefits. That is, legislators are more inclined to act on bills that would yield significant benefits to their constituents. Such bills make the involved bureaucracies happy (since they augment budgets) and consequently enhance a legislator's electoral chances. To quote Mayhew, "It becomes necessary for each congressman to try to peel off pieces of

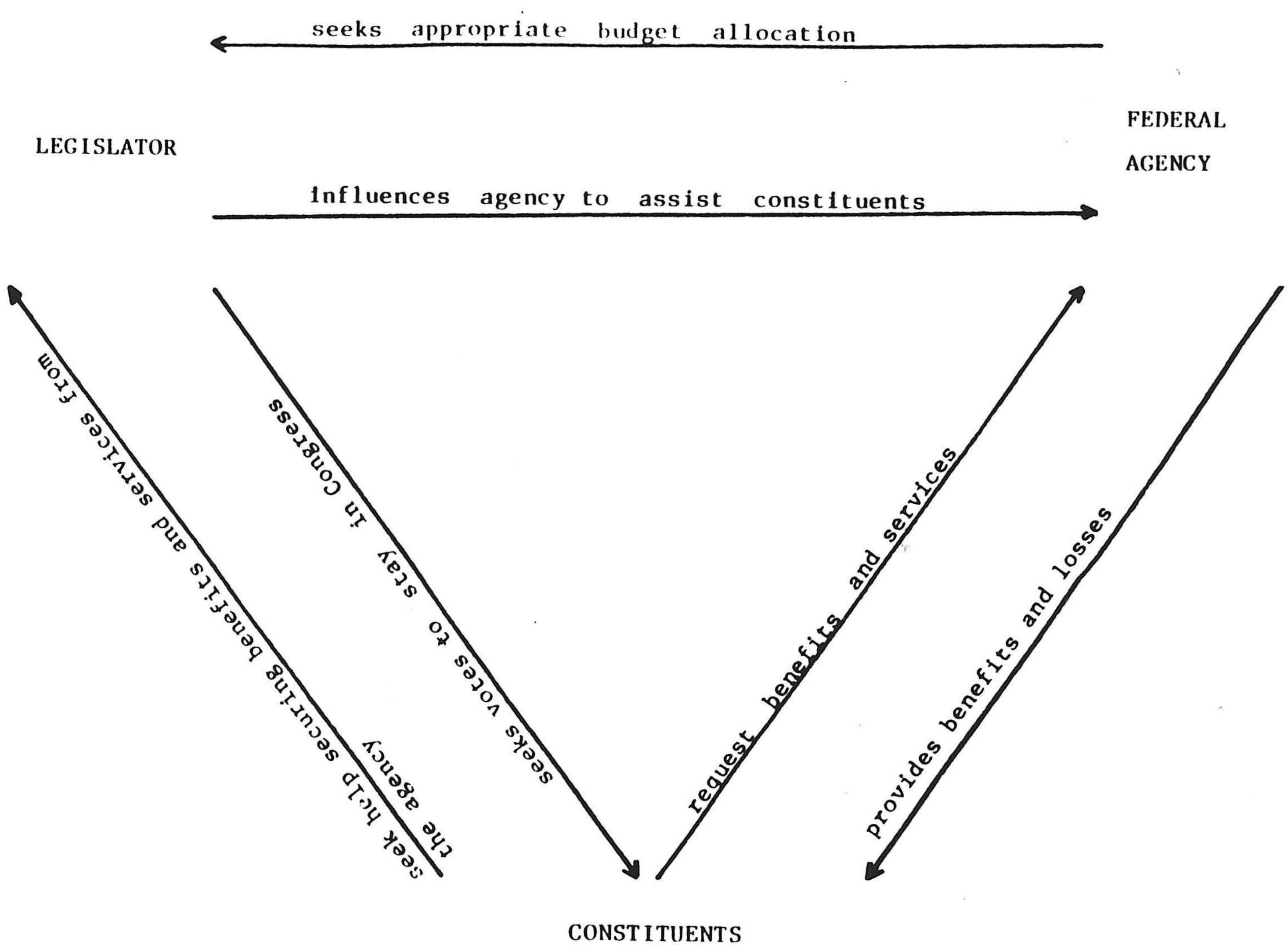

seeks appropriate budget allocation
LEGISLATOR
FEDERAL AGENCY
influences agency to assist constituents
seek help securing benefits and services from the agency
seeks votes to stay in Congress
request benefits and services
provides benefits and losses
CONSTITUENTS

FIGURE 2.1

government accomplishment for which he can believably generate a sense of responsibility. For the average congressman, the staple way of doing this is to traffic in what may be called 'particularized benefits'."[2] The relationship also tends toward servicing the better organized. "There is deference toward nationally organized groups with enough widespread local clout to inspire favorable roll call positions on selected issues among a majority of members · · · there is deference toward groups with disposable electoral resources whose representatives keep a close watch on Congressional maneuvers."[3] Lastly, it foments an inclination toward symbolism—the passage of legislation that expresses an attitude but no policy prescription or that contains a prescription which is not pursued. "Perhaps the best examples of congressional symbolism are those arising out of efforts to regulate business. Regulatory statutes are the by-products of congressional position taking at times of public dissatisfaction. They tend to be vaguely drawn."[4]

The success of this relationship—sometimes referred to in the literature as "the cozy little triangles"[5]—has depended very much on institutions that have developed within Congress. Perhaps the three most significant are the committee/subcommittee system, the rules, and the Congressional norm of reciprocity.

Each chamber of Congress—the House of Representatives and the Senate—is divided into committees, and in turn many committees are subdivided into subcommittees. Each subcommittee (or committee if not subdivided) is given jurisdiction over one or more policies. For instance, a majority of the subcommittees within the Agricultural Committee of the House of Representatives is more or less responsible for legislation pertaining to one farm commodity. And in general, congressmen and senators are assigned to those committees with jurisdiction over legislation that directly or indirectly affects their constituents.[6] Thus, committee assignments promote and maintain the triangles.

Assignments to the various committees are made by members of the Committee on

Committees (CC), usually party leaders. Each member of this committee has an inherent desire to maintain and increase influence in the chamber. If he can place House members for whom he is responsible, e.g., members of his state delegation, in their desired positions, then he will indirectly increase his influence. In the future, he can ask and normally will get from these members assistance on legislative matters, such as getting a certain bill passed. He is, of course, faced with certain constraints: certain rules for making committee assignments, desires of interest groups, and the desires or requests of other CC members. Nevertheless, through the process of restrained advocacy, he manages to place many of those under his "protectorship" in desirable positions.[7] Each CC member tries his best to accomodate other members' requests in negotiating committee assignments, e.g. increasing the size of membership in a committee whenever possible to accomodate conflicting interests.

The nature of the committee system is only part of the explanation for the persistence of the triangles. The objectives of legislators are oftentimes in conflict with each other. This may lead to the possibility of endless debates, i.e., majority rule cycling. The following (famous) example indicates the nature of the problem. Suppose there are three legislators, 1, 2, and 3, and three policies, A, B, and C, to choose from to attain a certain objective. Suppose further that the preferences of the legislators are represented by those in Table 2.1 below:

TABLE 2.1

Ranking of Preferences	Voters 1	2	3
1	*A*	*C*	*B*
2	*B*	*A*	*C*
3	*C*	*B*	*A*

Clearly, under simple majority rule, A would defeat B, B would defeat C, but C would defeat A. Thus, simple majority rule would be intransitive, resulting in the possibility of endless "cycling" (see Arrow (1951) and McKelvey (1978)). Congress has established certain rules to guard against "cycling". For instance, in the above example, if B and C were in fact amended versions of A, then a modified closed rule with two allowable amendments, B and C, would prevent cycling in the above example.[8] In many cases, committees use the rules as part of their strategy to get their bills passed by the whole chamber. Without the rules intense conflicts would be difficult if not impossible to resolve.[9]

In a seminal article on the impact of institutional arrangements on the decision-making process of a legislative body (1978), Shepsle shows convincingly that amendment rules and jurisdictional arrangements make it possible for legislators to reach a decision, and that the distribution of legislators' preferences affects the nature of the decision. His main argument boils down to the following: assuming an issue can be quantified so that the set of issues can be represented by a compact set in Euclidean space R (where m is the number of issues), if the correspondence between jurisdictions and the standard basis vectors of R is one-to-one, if amendments to proposed changes must be germane, and if preferences of each legislator over issues are single-peaked in the direction of any basis vector, then a "structure induced" equilibrium exists.

A jurisdiction is a set of issues over which a committee within the legislative body has authority. In Euclidian space it is represented by a subset of the standard basis of R^m, $\{e_1, e_2, \ldots, e_m\}$ where $e_k = (0, \ldots, 0, 1_k, 0, \ldots, 0)$. A one-to-one correspondence between jurisdictions and the standard basis vectors means that a jurisdiction is restricted to one issue, i.e., one basis vector e_k. Shepsle calls this kind of jurisdictional arrangement simple.

An amendment refers to a change in the current state of affairs—the status quo. Germaneness under simple jurisdictions means that changes that the whole body can make over a proposal forwarded by a committee are restricted to "movements in the direction of the single basis vector" representing the single issue whose current state the committee proposes to change. At this point, I wish to make clear an assumption which Shepsle makes implicitly: a change. At this point, I wish to make clear an assumption which Shepsle makes implicitly: a committee (or subcommittee) may have several jurisdictions, but it can only introduce changes one jurisdiction at a time. For example, if the committee has control over two jurisdictions, it cannot simultaneously propose a change in each.

Shepsle's assumption regarding preferences simply means that a legislator has a unique most-preferred point along any line parallel to a basis vector. In Figures 2.2a through 2.2c, I give examples illustrating the three assumptions, given there are only two issues, i.e., $m = 2$. In Figure 2.2a, the two simple jurisdictions are represented by the vectors $e = (1, 0)$ and $e = (0, 1)$. Proposals to change the status quo x and any amendments thereafter are limited to movements in the direction of e_1 or of e_2; they must lie on line l^0 or $l^{0'}$. This is the restriction imposed by simple jurisdictions and germaneness. Figure 2.2b depicts a legislator with "eliptical" preferences. The legislator has a bliss or ideal point at (x_1^{oj}, x_2^{oj}) and his indifference curves are ellipses. Moreover, any point on an ellipse, such as z, would be preferred by him to any other point on larger ellipses, such as z'. Thus, along any given line parallel to $e_1(e_2)$, such as $l\,(l')$, he has a most-preferred point $z^*(l)(z^*(l'))$—he would prefer this point to any other point on $l\,(l')$. Alternatively, his utility function along a line parallel to $e_1(e_2)$ is single-peaked and strictly concave.[10]

A structure-induced equilibrium is a point in the issue space X contained in R^m that cannot be altered under simple majority rule, given prespecified restrictions on jurisdictional arrangements and the amendment process; its position, and even its existence, depends on the jurisdictional arrangements and amendment rules adopted.[11] Shepsle shows that under simple jurisdictions and germaneness of amendments a structure induced equilibrium exists. His proof can be explained graphically.

Consider the case of five legislators with eliptical preferences over two issues ($m = 2$) and two committees one with jurisdiction over e_1 and the other over e_2. Figure 2.3a illustrates the

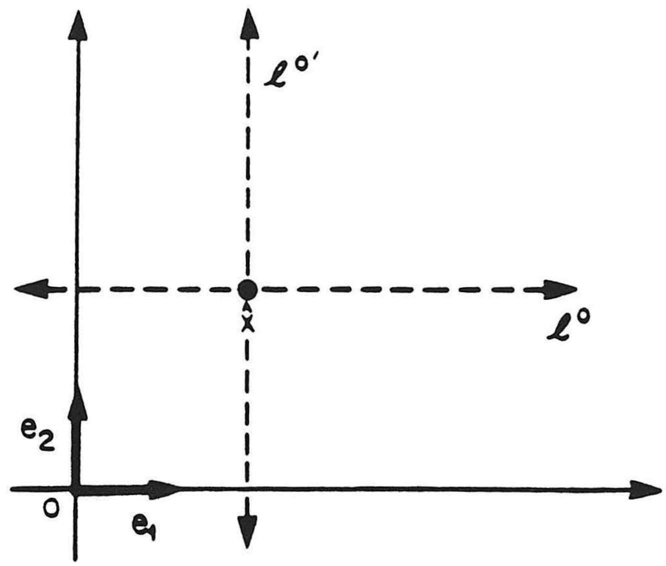


FIGURE 2.2 a

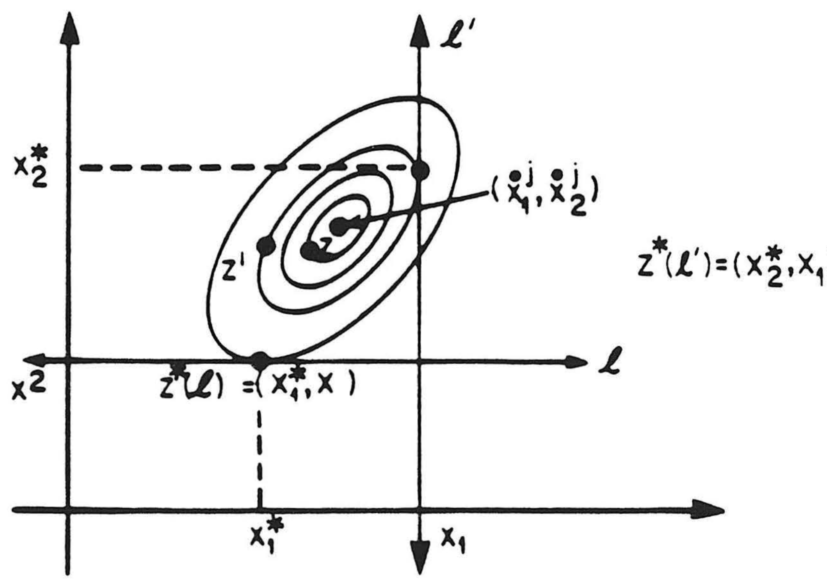


FIGURE 2.2 b

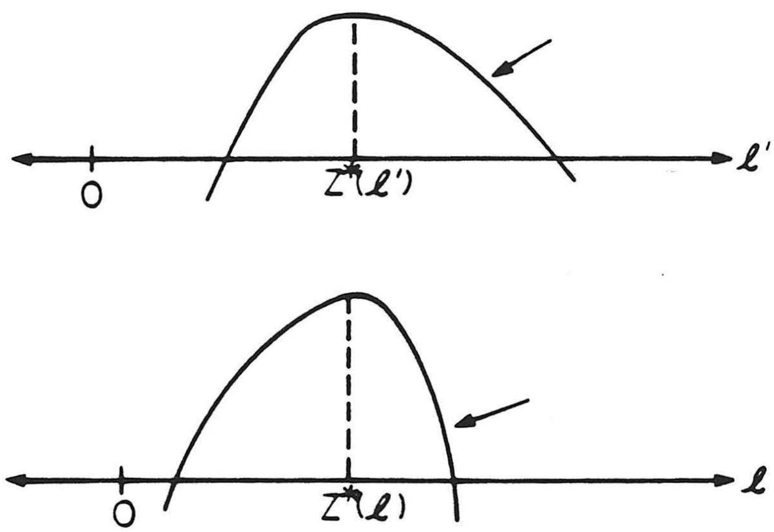


FIGURE 2.2 c

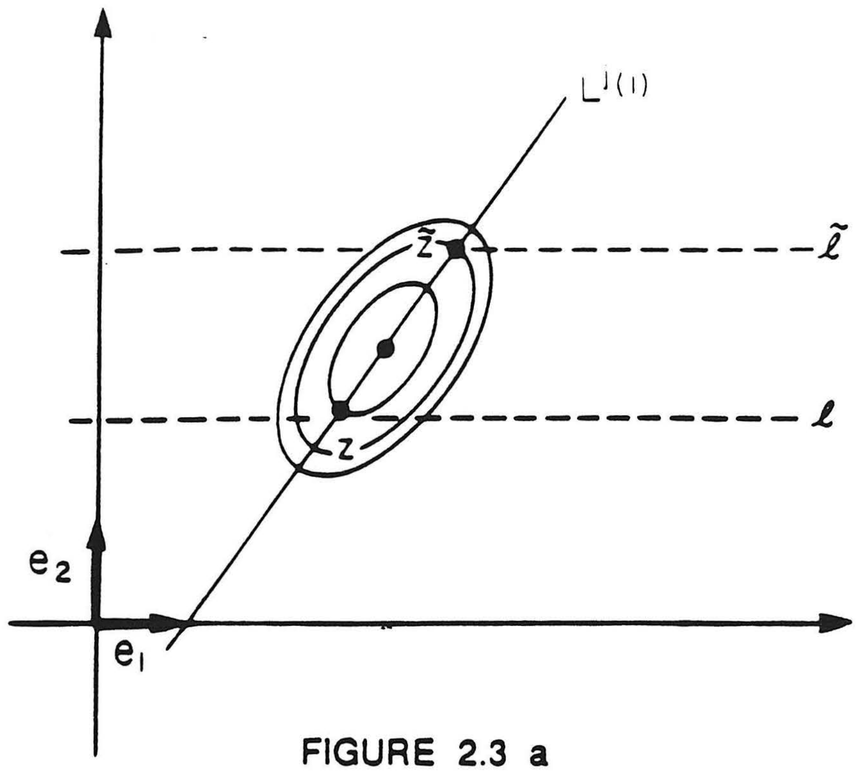


FIGURE 2.3 a

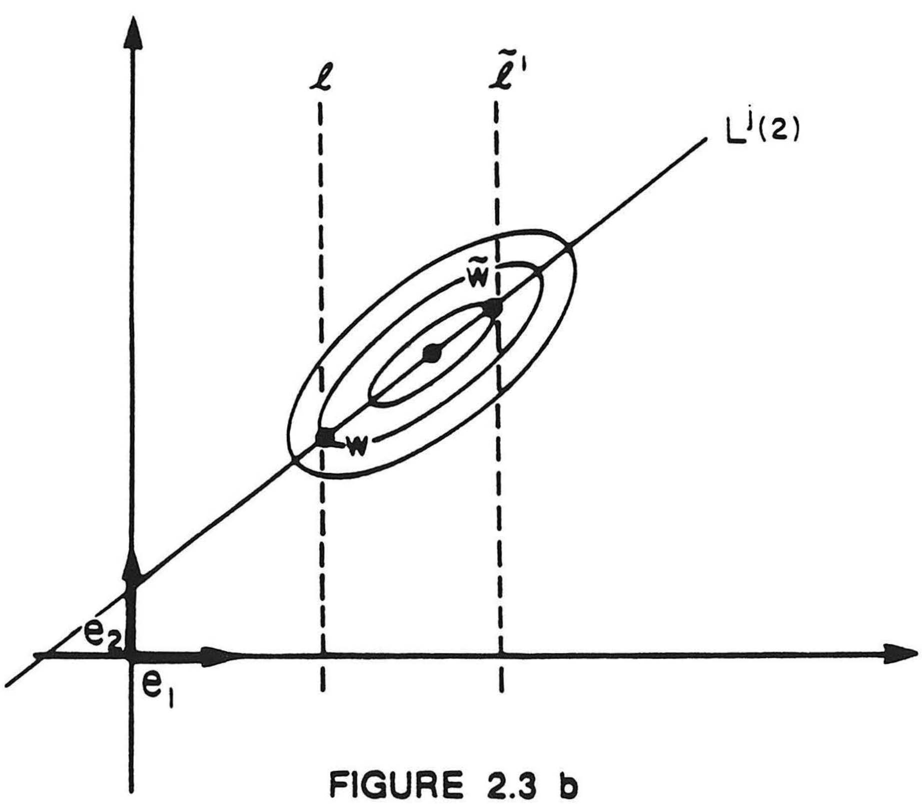


FIGURE 2.3 b

that any point on it corresponds to the legislator's most-preferred choice along a line that is parallel to e_1 and that cuts through the point. For instance, z is his most-preferred point along l and $\tilde{z}$ along $\tilde{l}$. Figure 2.3b illustrates the same preferences but with a different line, $L^j(2)$. Any point on $L^j(2)$ corresponds to the legislator's most-preferred choice along a line passing through the point and parallel to e_2. For example, w is his most-preferred point on l' and $\tilde{w}$ on $\tilde{l}'$.

The assumed preferences of each legislator together with his respective lines $L^j(k)$, $j = 1, \ldots, 5$ and $k = 1, 2$, are illustrated in Figure 2.3c. The lines $L^j(1)$ are reproduced in Figure 2.3d and the "median voter" line for issue 1, Ł(1), superimposed on it. The "median voter" line is derived in the following way. Pick any arbitrary line parallel to e_1 such as l in Figure 2.3d. Along this line, legislator 5 is the median voter. Recall that the intersection of $L^j(1)$ with l represents legislator j's most-preferred choice along l; hence, legislator 5's most-preferred choice along l would be the median along l. Suppose we pick some other line such as l'. Then, by the same reasoning, legislator 1's most-preferred choice would be the median along l'. If we do this for all possible lines parallel to e_1 then we would end up tracing the line Ł(1). In short, each point on Ł(1) represents the median voter's choice along some line parallel to e_1.

Similarly, the lines $L^j(2)$ are reproduced in Figure 2.3e with the "median voter" line for issue 2, Ł(2). A point on Ł(2) represents the median voter's choice along a line parallel to e_2. For example, legislator 3's most preferred choice along $\tilde{l}$, $w^3(\tilde{l})$, is the median along $\tilde{l}$.

Both "median voter" lines Ł(1) and Ł(2) are reproduced in Figure 2.3f. Their intersection $\hat{x}$ is a structure-induced equilibrium under simple jurisdictions and germaneness. To see this, assume $\hat{x}$ is the status quo. Because jurisdictions are simple, a committee can only propose a change either along $\hat{l}$ or $\hat{l}'$ but not both. Assume the committee with authority over issue 1 is composed of legislators 1, 2, and 3, and suppose it proposes z as an alternative to $\hat{x}$. The whole body (the five legislators) can amend this proposal. However, since amendments must be germane, then any change that it would make has to be along $\hat{l}$. Since $\hat{x}$ is the median voter's

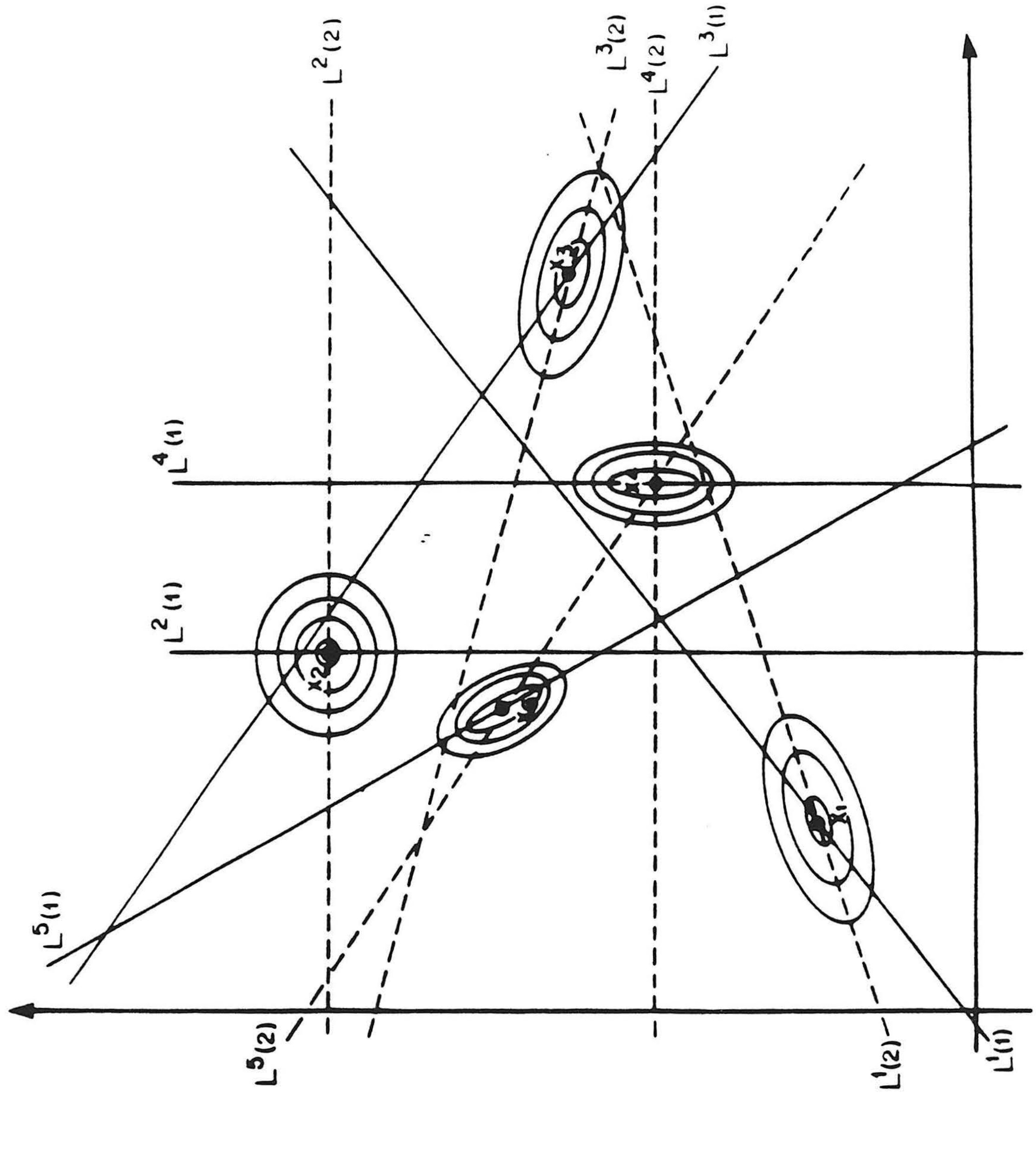


FIGURE 2.3 c

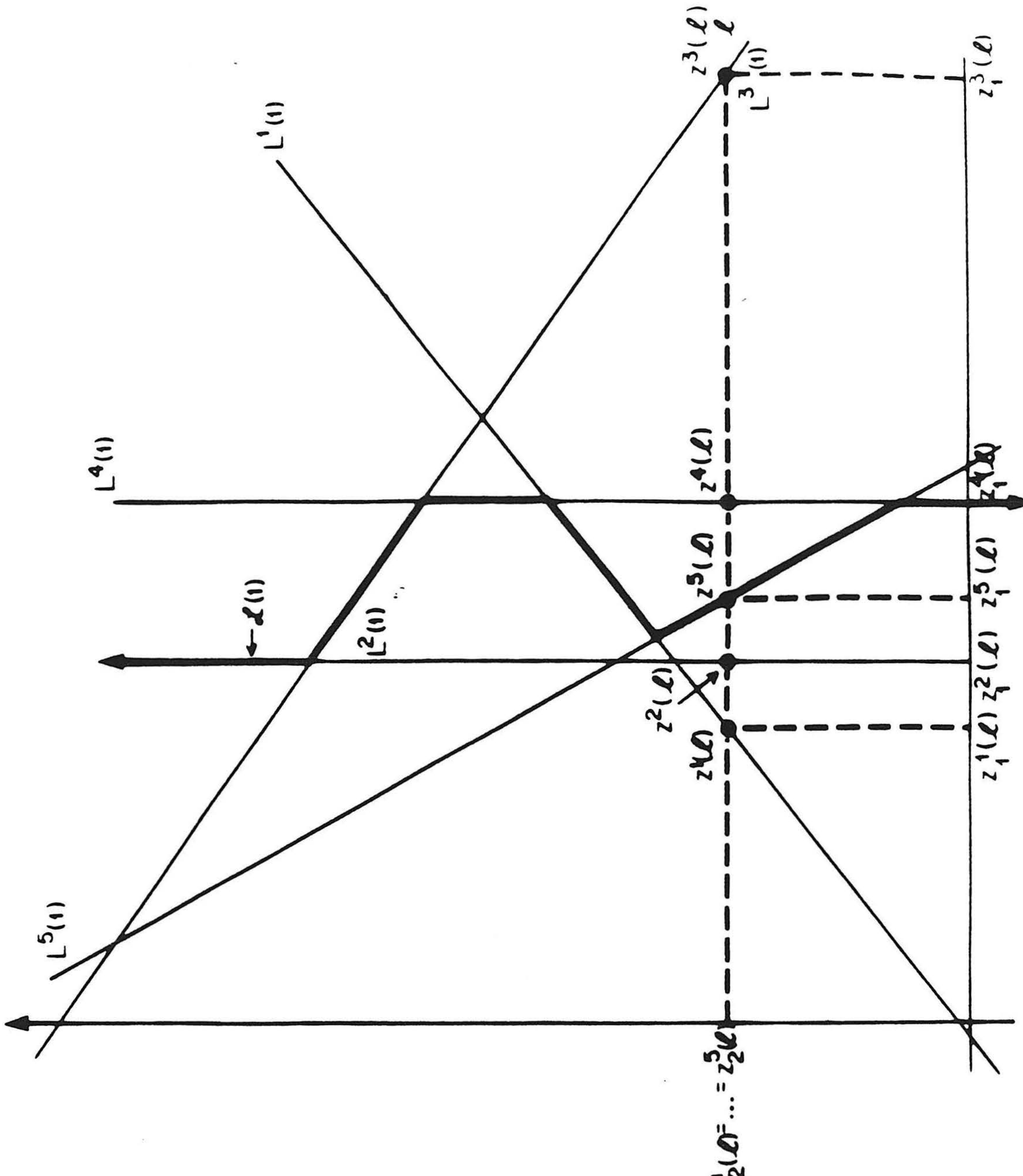

L¹(1)
L²(1)
L³(1)
L⁴(1)
L⁵(1)
ℓ(1)
ℓ
z³(ℓ)
z⁴(ℓ)
z⁵(ℓ)
z²(ℓ)
z¹(ℓ)
z₁³(ℓ)
z₁⁵(ℓ)
z₁²(ℓ)
z₁¹(ℓ)
z₂¹(ℓ) = ... = z₂⁵(ℓ)

FIGURE 2.3 d

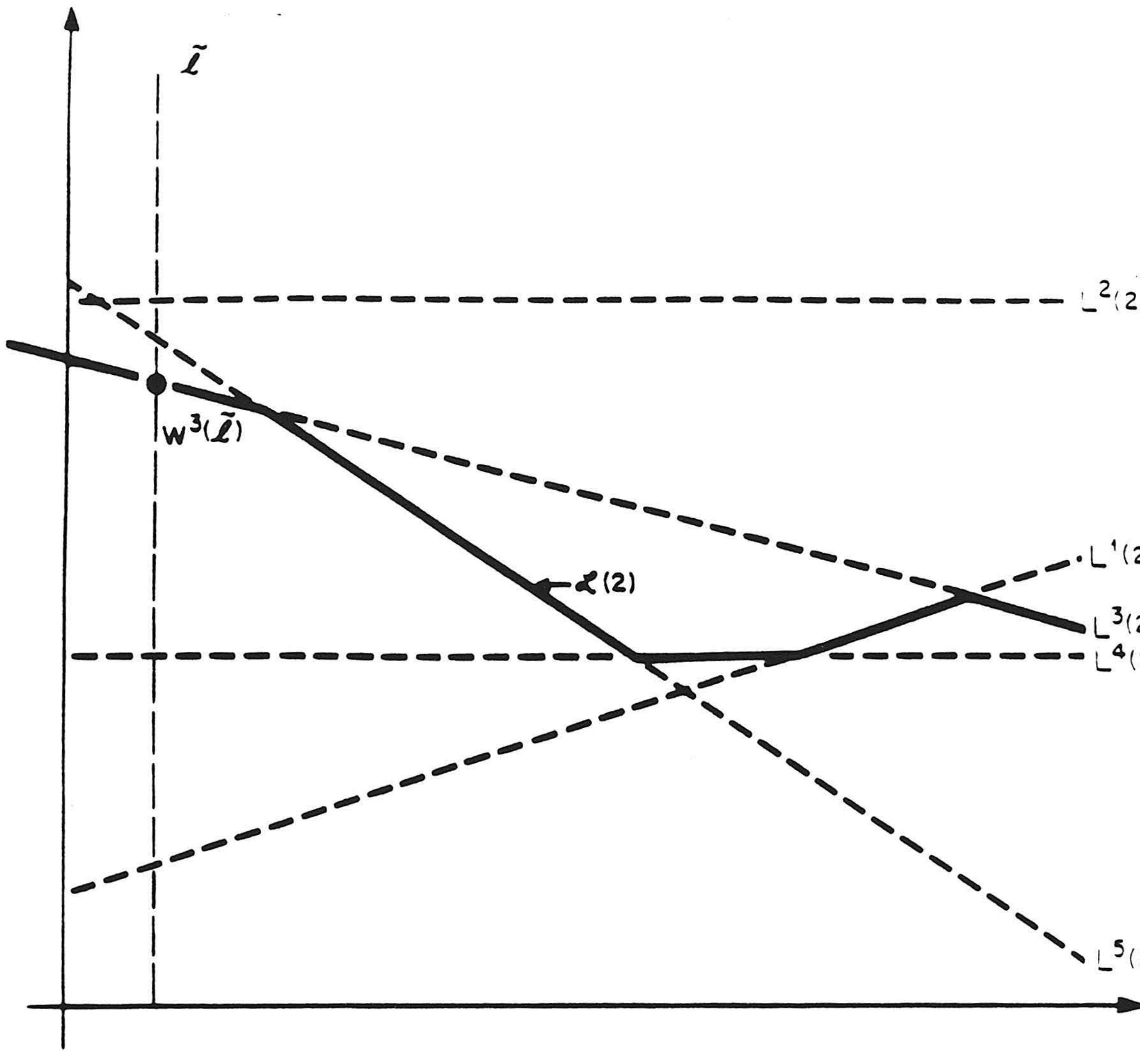


FIGURE 2.3 e

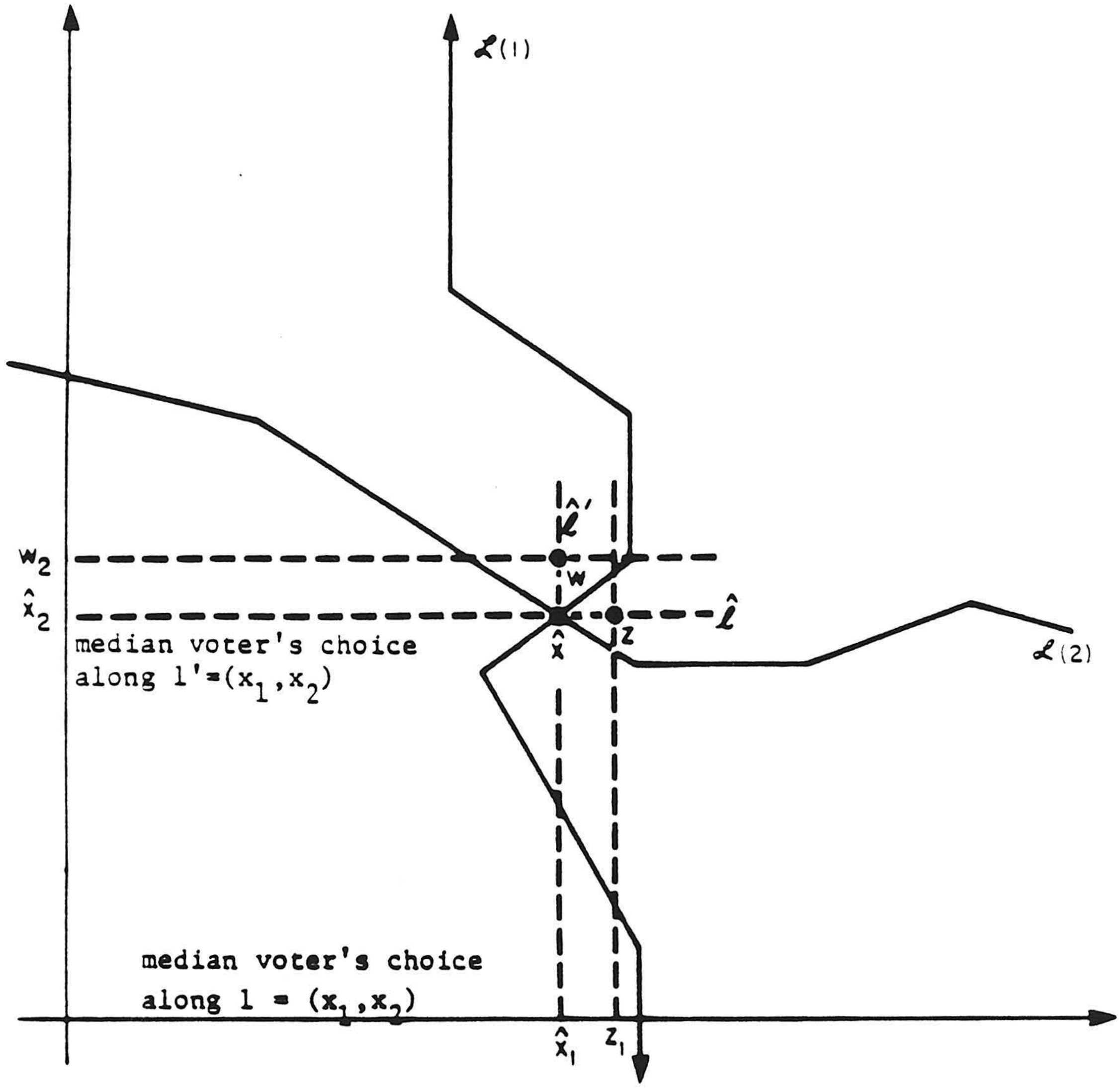

$\mathcal{L}(1)$
$\hat{\ell}'$
w_2
$\hat{x}_2$
w
z
$\hat{\ell}$
$\hat{x}$
median voter's choice
along l'=(x1,x2)
$\mathcal{L}(2)$
median voter's choice
along l = (x1,x2)
$\hat{x}_1$
z_1

FIGURE 2.3 f

choice along $\hat{l}$, then clearly it would dominate any proposal along $\hat{l}$. Thus z would ultimately be defeated by $\hat{x}$. The same argument can be made for proposals along $\tilde{l}$.

Norm-based models provide an alternative explanation for stable outcomes. Cooperation, implicit or explicit, is another way that cycles may be avoided. Political scientists often refer to the reciprocity norm among members within each chamber as an institution that greases the legislative machinery, reducing internal conflicts to minimal levels. In a clever piece of work, Axelrod explains why Congress would adopt such a norm. He argues that any two legislators in conflict are in some sense faced with a prisoner's dilemma. Consequently, they may not arrive at an agreement. In game theory, this in effect means the absence of a stable solution to a single play of a two-person prisoner's dilemma game. Axelrod shows that in an infinite number of plays of this game, a stable solution, a so-called Nash equilibrium, does exist. If each player pursued a tit-for-tat strategy vis-a-vis the other , then neither would have any incentive to use a different strategy, for this would only make him worseoff. A player follows a tit-for-tat strategy if he "cooperates" on the first play of the game and then in succeeding plays does whatever the other player did in the previous play of the game. More specifically, legislator j would vote for legislator k's sponsored bill the first time around, but in succeeding session would vote for k's bill only if k had voted for his favored bill the last time around. Axelrod then states and proves the following proposition: if a sufficient number of individuals mutually cooperating with each other is infused into a group which is composed of mutually uncooperative individuals, and the former play a tit-for-tat strategy with the latter, then over time the latter will realize that cooperation is the best strategy. The import of this proposition is that eventually reciprocity becomes the norm in a legislative body such as the House of Representatives and the Senate. The last of his propositions implies that reciprocity, once established, will remain the norm. If a nice strategy such as tit-for-tat cannot be invaded by a single individual then it cannot be invaded by any cluster of individuals.[12]

Both types of political models provide an answer to the question of the existence of price support programs. The interaction of electoral objectives and congressional institutions makes it possible for producers to obtain and maintain favorable price support legislation. However, the model is deficient. First, it does not address the link between economic factors and legislators' preferences and thus policy outcomes. Price support policies (as well as most other economic policies) affect and divide the constituents of a legislator. A price support affects demand and supply in a way that yields losses to consumers/taxpayers and gains to producers. Thus it divides a legislator's constituency into two opposing groups and, via the electoral objective, induces legislators preferences over the price support issue.

This deficiency becomes obvious when one considers changes in economic conditions. For example, a shift in demand and/or supply alters the loss-gain configuration (of a price support policy) and thus the responsiveness of consumers and producers within a legislator's constituency. The latter in turn alters the preferences of legislators and consequently the policy outcome. In terms of a spatial model, changes in economic conditions ultimately move the ideal points of legislators, and thus are likely to change the equilibrium outcome. In short, the political model cannot adequately deal with changing economic conditions.

Second, the models assume either a world in which there is no bargaining or one characterized by complete harmony. Shepsle-based models disregard logrolling that frequently goes on in Congress. Norm-based models, on the other hand, assume that logrolling is to be expected. Neither class is very useful in analyzing the behavior of a specific committee (more precisely, members thereof) vis-a-vis the rest of the chamber. Committees generally face a hostile environment on the floor, but, often enough, manage to form and defend a logroll with other legislators.

And last, because it does not adequately address the relationship between economic factors and legislators' preferences, the political models cannot help resolve the problem of instrument choice. A price support can be maintained using different methods. Economic factors determine in part the gains and losses stemming from a particular method, and thus are crucial for determining which method is best for whatever criterion is used. It is when such economic considerations are combined with political ones that we achieve insights into why particular policy instruments are chosen.

In the next chapter I will present a voting model which identifies conditions under which a committee can successfully create and defend a logroll with noncommittee members whose preferences conflict with those of its members. The conditions, in fact, are representative of those facing the Agricultural Committee, at least in the House. The model can be thought of roughly as a Shepsle model with bargaining.

In chapter four I will develop a simple formal model that is capable of explaining why price support programs might exist. Like the political models, the model which I develop takes into account electoral objectives, political factors, the committee system, and jurisdictional arrangements. In addition, however, it includes economic factors and employs some notion of committee influence. The model generates testable implications concerning the behavior of price supports. I derive some comparative static predictions from the model and, in the last section of the chapter, then test these predictions statistically using data from selected U.S. agricultural markets.

FOOTNOTES TO CHAPTER TWO

1. See, for instance, Mayhew (1974), Fiorina (1977), Ferejohn (1977), Arnold (1979), and Fenno (1973).

2. Mayhew, D.R. 1974. *Congress: The Electoral Connection*. New Haven: Yale University Press.

3. Mayhew, op cit.

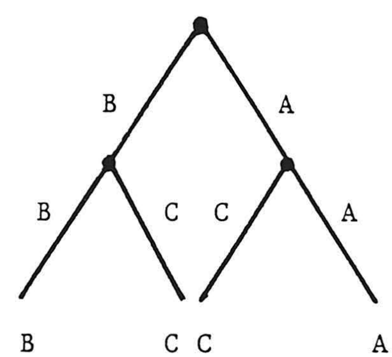
4. Mayhew, op cit.

5. Fenno, in particular, gives a good discussion of the "cozy little triangles" in his book *Congressmen in Committees* (1973).

6. See Shepsle's *The Giant Jigsaw Puzzle* (1978).

7. See Shepsle (1978).

8. Assume B is first pitted against A and then C against the winner. Given that at most two amendments are allowed then the game tree would be as follows:



Given the preferences of the three legislators, B would defeat A in the second round C would defeat B. Thus C would win.

9. See William Riker (1958) and Stanley Bach (1981) for a discussion of the effect of rules on Congressional decision making.

10. A utility function $U : X \rightarrow R$ that is continuous and strictly quasi-concave has a unique most preferred point along lines parallel to the basis vectors provided its domain X is compact.

11. In the degenerate case—no rules—an equilibrium may not exist. Moreover, even if one exists, it would be highly unstable in the sense that it could be eliminated by a slight change in the preference of a single legislator (see Plott, 1960).

12. An individual invades a strategy if he tries to make himself better off by using some other strategy while the others continue to use the strategy.

CHAPTER 3

COMMITTEE POWER IN A SHEPSLE WORLD

Much of the work on the power of committees over policy outcomes stems from the seminal work of Shepsle (1978). Shepsle demonstrates that institutional structures—a committee system, jurisdictional arrangements, and amendment rules—act to constrain choices among alternative policy bundles and consequently minimize the possibility of majority rule cycles inherent in institution-free voting environments. Two major implications follow from this. First, a majority voting equilibrium exists in a structured environment (called a structure-induced equilibrium). And second, committees will have some degree of influence over the character of the equilibrium.

The literature on committee power attributes power to a committee's ability to control agendas (Denzau and Mackay, 1983; Fiorina and Plott, 1978; Gilligan and Krehbiel, 1985; Krehbiel, 1985; Plott and Levine, 1978; Shepsle and Weingast, 1984). A committee can influence policymaking in the following way: it may choose not to propose any changes to policies over which it has jurisdiction, i.e., gatekeeping. Or, through the strategic use of amendment rules, it may restrict the set of alternatives and limit the possible paired comparisons among these alternatives. In either case, the committee manipulates the outcome.

Implicit in this literature, it seems, is the assumption that bargaining with noncommittee members is infeasible or yields inferior outcomes. It is generally assumed that a committee faces a competitive, if not hostile, environment on the floor. This is not at all surprising since it has been convincingly argued that potential winning coalitions are essentially unstable (Cohen, 1979; McKelvey, 1976 and 1979; Schofield, 1978). These instability results are derived, however, from institution-free models. In this chapter I argue that institutional arrangements may endow a committee with some bargaining power. Specifically, I show that if a committee is given jurisdiction over a policy that does not yield benefits to its members but may yield potential benefits to a sufficient number of legislators outside the committee (an "extraneous" jurisdiction), then the committee can create and defend a winning coalition.

In my analysis I attribute an expanded role to jurisdictional arrangements in providing a committee with influence. Previous work accords an "agenda control" role to such arrangements: assignment of jurisdictions to a committee gives the committee a "first move" advantage and consequently some ability to control the agenda within these jurisdictions. I demonstrate that, given a committee has the prerogative to form a coalition with noncommittee members and to choose the composition of the coalition (see, for instance, Ferejohn, 1984), then, depending on their nature, these arrangements may also confer some bargaining power to the committee.

The situation I posit is not a purely theoretical construct. Ferejohn (1984) and Ripley (1969) have pointed out that control over Food Stamps legislation combined with the above mentioned institutional structures have given the the Agricultural Committee significant leverage over the passage of controversial price support programs.[1] As stated by Ferejohn:

> Congressional committees, it is argued, have a monopoly right to initiate legislation within their own jurisdictions. Moreover, at least in the House, rules of germaneness require that amendments brought against such proposals are confined to the subject matter of the proposal. When legislation is reported by committees, legislative consideration is managed by the committee leaders and is governed by rules of amendment that require that, in the end, the bill as amended is voted up or down . . the legislated outcome is achieved by packaging congressionally favored foodstamps legislation with less popular commodities programs.[2]

A. <u>The Basic Assumptions</u>

To start with, I assume a committee has the ability to choose which members of the legislature (outside the committee) it will collude with and, likewise, can package its members' projects together with projects that are beneficial to those legislators it has included in the coalition. For the latter, I am, in effect, assuming that the committee has jurisdiction over the projects of the other legislators or equivalently can package them in such a way that they fall within its jurisdiction. I let C represent the committee, V the set of legislators chosen by C to be part of the coalition, and S the rest of the legislature.[3] One can think of V as the swing or pivotal group whose votes C wishes to attract and $(C \cup V)$ as the coalition C chooses. For facility, I let n be the size of the legislature, n_1 the size of C, n_2 the size of V, and n_3 the size of S.[3] I assume n is odd and both n_1 and n_2 are less than $[(n-1)/2]$—neither C nor V form a majority. The latter implies that $(C \cup V)$ and $(S \cup V)$ constitute a majority and thus a potential winning coalition, i.e., $(n_1 + n_2) \geq [(n+1)/2]$ and $(n_2 + n_3) \geq [(n+1)/2]$.

To simplify matters, I assume that members of C each have identical projects of scale x_1, each yielding benefits $b_1(x_1)$ and costs $c_1(x_1)$ to his constituents. Furthermore, I suppose that C can offer each member of V a project of scale x_2 with benefits $b_2(x_2)$ and costs $c_2(x_2)$.[4] The cost of any project is spread out equally across all districts. Thus, if all the projects of legislators in $(C \cup V)$ are approved, then the cost to each district is $(1/n)[n_1 c_1(x_1) + n_2 c_2(x_2)]$, which we denote $c(x_1, x_2)$. The benefit and cost functions satisfy the following properties: for $j = 1, 2$,

$$b_j' > 0, b_j'' < 0, b_j(0) = 0 \,, \tag{3.1a}$$

$$c_j' > 0, c_j'' > 0, c_j(0) = 0 \,, \tag{3.1b}$$

and letting

$$P_j(x_j) = [b_j(x_j) - (n_j/n)c_j(x_j)] \,, \tag{3.1c}$$

then $P_j(x_j) > 0$ for all x_j sufficiently close to zero.

These properties imply that there is some $\bar{x}_j > 0$ such that $P_j(\bar{x}_j) = 0$. Since $[0, \bar{x}_j]$ is compact and P_j continuous then $\hat{x}_j = \underset{[0,\bar{x}_j]}{argmax}\, P_j(x_j)$ exists; in fact, $\hat{x}_j$ is an interior point. I illustrate this in Figure 3.1 below.

The objective of C-type legislators is to get their projects approved by the floor. Being in the minority, they cannot do this without the support of noncommittee members. To obtain the necessary support, they formulate an omnibus bill composed of their projects, as well as those of the V-type legislators, and propose it to the floor. We denote this bill (x_1, x_2) and the payoff to the constituents of a legislator in $(C \cup V)$ under the bill by $M_j(x_j, x_j) = [b_j(x_j) - c(x_1, x_2)]$.

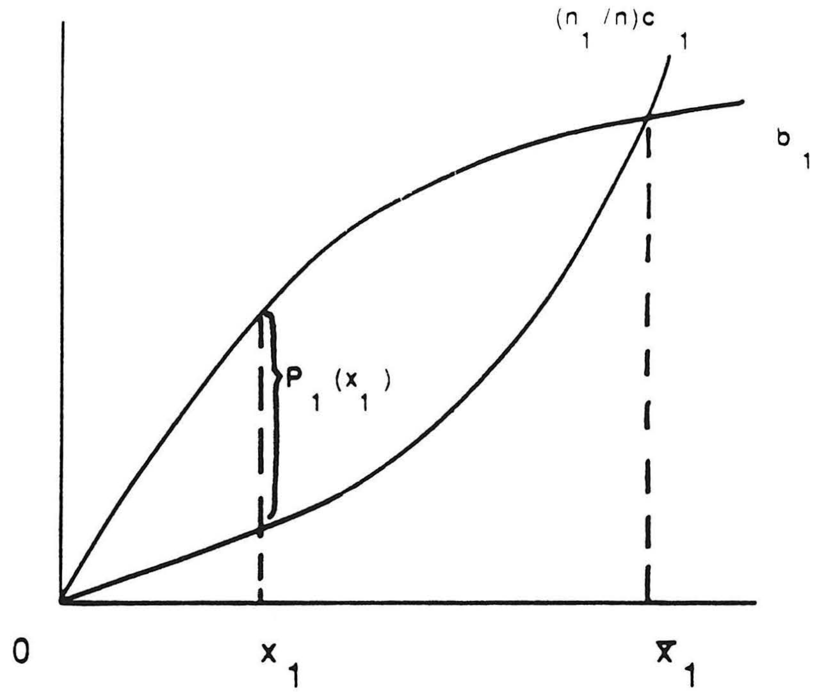


FIGURE 3.1

The payoff to an S-type legislator is, of course, $[-c(x_1, x_2)]$. I assume the payoff functions satisfy,

$$M_j(\hat{x}_1, \hat{x}_2) > 0 \,.^5 \qquad (3.2)$$

Property (3.2) implies that for some neighborhood N of $(\hat{x}_1, \hat{x}_2)$, $M_j(x_1, x_2) > 0$ for all (x_1, x_2) in N. We depict this in Figures 3.2a and 3.2b.

Finally, I assume that a legislator's preferences over payoffs to his constituents are representable by a concave strictly increasing function u_1. This implies the following: for any bill (x_1, x_2) and any $a_1, a_2 > 0$, if $i \in C$,

$$u_i(M_1(x_1, x_2 - a_2)) > u_i(M_1(x_1, x_2)) > u_i(M_1(x_1 - a_1, x_2)) \,;$$

if $i \in V$,

$$u_i(M_2(x_1 - a_1, x_2)) > u_i(M_2(x_1, x_2)) > u_i(M_2(x_1, x_2 - a_2)) \,;$$

if $i \in S$,

$$u_i(c(x_1 - a_1, x_2)) > u_i(c(x_1, x_2) \,,$$
$$u_i(c(x_1, x_2 - a_2)) > u_i(c(x_1, x_2)), \text{ and}$$
$$u_i(c(x_1 - a_1, x_2 - a_2) > u_i(c(x_1, x_2)) \,.$$

I am, of course, assuming $M_j(x_1, x_2) > 0$. Note that (0, 0) is assumed to be the status quo, and that any member of $(C \cup V)$ prefers (x_1, x_2) to (0, 0), and any member of S prefers (0, 0) to (x_1, x_2).

The character of the committee's (C) power differs with respect to the designated rules for amending the bill and the response of the S-type legislators, whether they behave collusively or noncollusively. I begin by analyzing the situation under noncollusive behavior by the S-types.

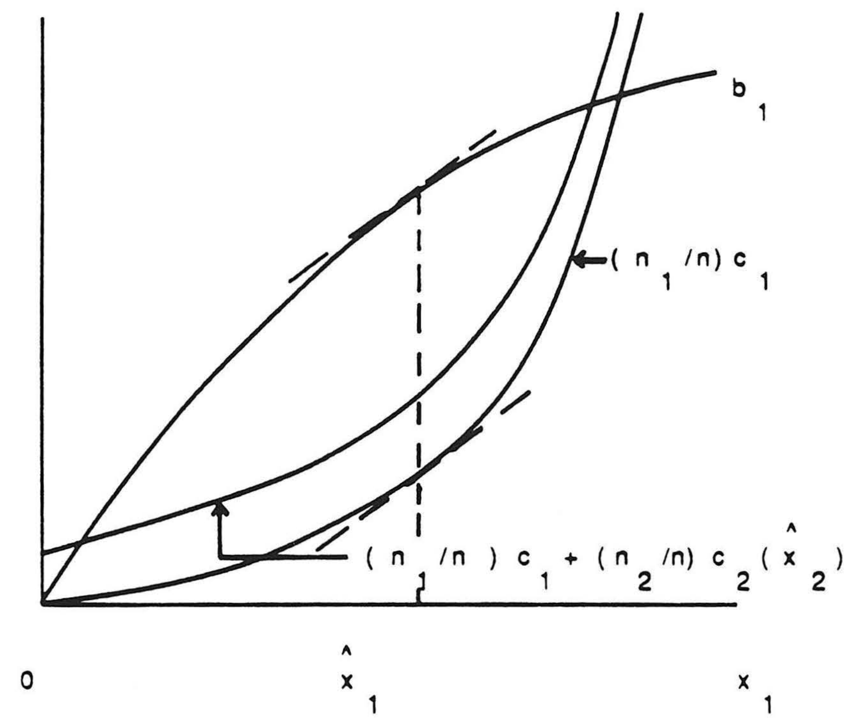


FIGURE 3.2 a

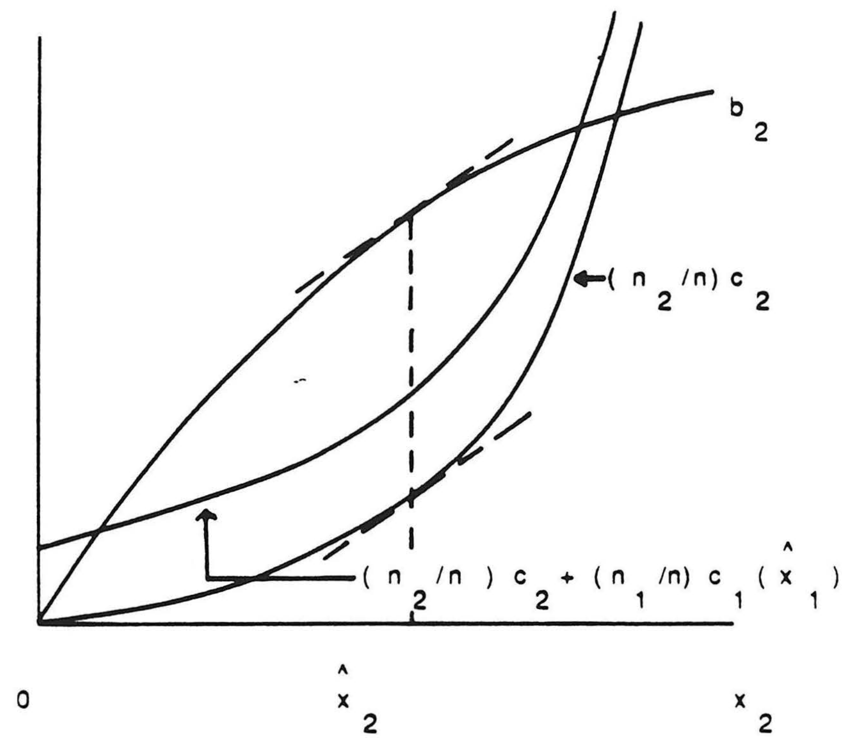


FIGURE 3.2 b

B. Noncollusion by S

Closed Rule:

Under a closed rule, C proposes a bill (x_1, x_2) which the floor then must vote up or down; we will call this game $VG1$ (voting game 1). By hypothesis, all S-types will vote against the bill. Thus the outcome depends on how the members of $(C \cup V)$ vote. Each member of the coalition is faced with three possible situations: E_1—a sufficient number (greater than or equal to $(n + 1)/2$) of his colleagues in $(C \cup V)$, excluding himself, vote for the bill, E_2—his vote is pivotal, and E_3—less than $(n - 1)/2$ of his colleagues, excluding himself, vote for the bill.

The payoff matrix of a V-type is depicted in Table 3.1 below. The term m_{lk} is the payoff to the legislator's constituents if he plays his l^{th} strategy and the k^{th} situation occurs—$l = 1, 2$ and $k = 1, 2, 3$. If E_1 occurs, then the outcome is the same regardless of how the legislator votes. Thus, $m_{11} = m_{21}$. Since the bill is approved, then $m_{11} = M_2(x_1, x_2) = [b_2(x_2) - (1/n)(n_1c_1(x_1) + n_2c_2(x_2))$. Likewise, if E_3 occurs, then the legislator's vote is inconsequential, and so $m_{13} = 0$. However, if E_2 occurs, then his vote is crucial. If he votes for the bill, then the bill passes, and his payoff is $m_{12} = M_2(x_1, x_2)$. If he rejects the bill, then it fails, and he gets nothing, i.e., $m_{22} = 0$. Thus, v_1 is a dominant strategy for a V-type legislator. The same argument can be made for a C-type legislator. Consequently, the bill passes under a closed rule. An equilibrium then is characterized by an up vote from C-type and V-type legislators.

TABLE 3.1

	E_1	E_2	E_3
v_1	m_{11}	$m_{12} = b_2(x_1) - \frac{1}{n}[n_1c_1(x_1) + n_2c_2(x_2)]$	m_{13}
v_2	m_{21}	$m_{22} = 0$	m_{23}

The situation is more complex under a germaneness rule. I turn to this in the next section.

Germaneness Rule:

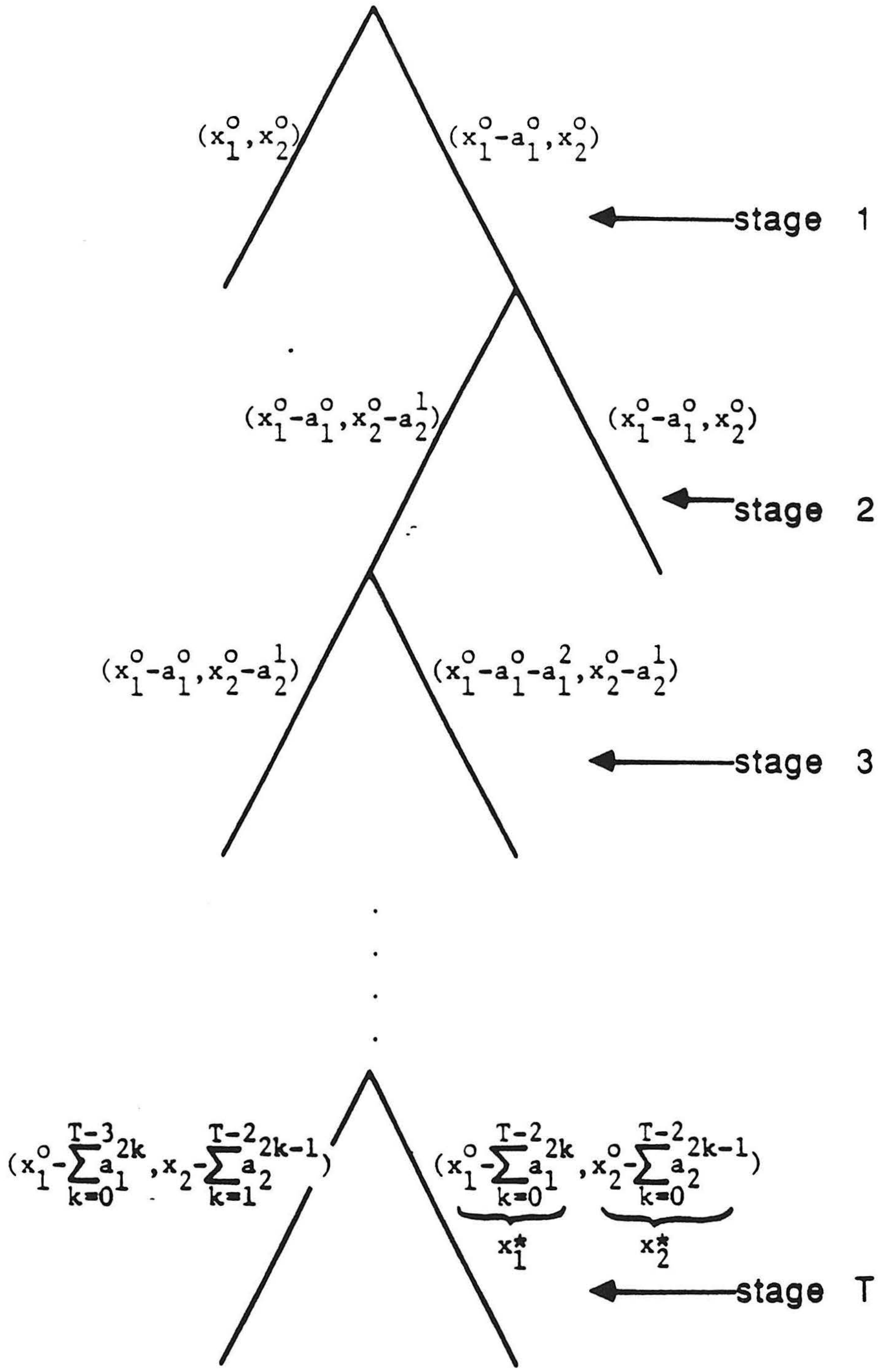
An amendment can be represented by a pair (a_1, a_2) where a_j is a change in the scale x_j. I define germaneness as follows: an amendment is germane if and only if $a_1 = 0$ or $a_2 = 0$ but not both. Thus, the bill can be altered only one dimension at a time; the same is true for any amended version of the bill.

Germane amendments (to the bill and to amended versions) that scale down projects will dominate floor voting. Thus, at any stage of the amendment process the amended bill being considered represents a scaling down of the C-type projects or the V-type projects (but not both). I present an example in Figure 3.3. The initial amendment scales down the C-type projects by a_1^0, which of course passes. In the second stage, an amendment to contract the V-type projects by a_2^1 is proposed and accepted. The third stage amendment $(0, -a_1^2)$ reduces the C-type projects even further. The process continues until some final stage T. I denote the final amended version of the bill by (x_1^*, x_2^*).

Clearly, the outcome of the amendment process is uncertain; any pair (x_1, x_2) has a probability (perhaps zero) of being the final amended version. Thus, when deciding whether to accept the initial amendment or not, a V-type legislator must effectively choose between a certain alternative that yields a positive return and a risky one which may yield a higher or lower (perhaps even negative) return.[6] Now let $F(x_1, x_2; a_j^0, x_1^0, x_2^0)$ be the cumulative distribution function that describes the probability that, given a proposed bill (x_1^0, x_2^0) and an initial amendment $(a_1, 0)$ or $(0, a_2)$, the outcome of the process satisfies $x_1^* \le x_2$ and $x_2^* \le x_2$. Assume a density function for F exists and is given by $f(x_1, x_2; a_j^0, x_1^0, x_2^0)$. Then, if the initial amendment is approved a V-type knows that the net benefits to his constituents would be,

$$E^0 M_2(x_1, x_2) = \int_0^{\bar{x}_1}\int_0^{\bar{x}_2} M_2(x_1, x_2) f(x_1, x_2; a_j^0, x_1^0, x_2^0)\, dx_1 dx_2 .^7$$

Hence, assuming his preference function is linear with respect to constituents' net benefits, a



(x_1^o, x_2^o)
$(x_1^o - a_1^o, x_2^o)$
stage 1
$(x_1^o - a_1^o, x_2^o - a_2^1)$
$(x_1^o - a_1^o, x_2^o)$
stage 2
$(x_1^o - a_1^o, x_2^o - a_2^1)$
$(x_1^o - a_1^o - a_1^2, x_2^o - a_2^1)$
stage 3
$(x_1^o - \sum_{k=0}^{T-3} a_1^{2k}, x_2 - \sum_{k=1}^{T-2} a_2^{2k-1})$
$(x_1^o - \sum_{k=0}^{T-2} a_1^{2k}, x_2^o - \sum_{k=0}^{T-2} a_2^{2k-1})$
x_1^*
x_2^*
stage T

FIGURE 3.3

V-type will reject the initial amendment to the bill if and only if,

$$M_2(x_1^0, x_2^0) > E^0 M_2(x_1, x_2) . \tag{3.3a}$$

Similarly, a C-type will reject the initial amendment if and only if,

$$M_1(x_1^0, x_2^0) > E^0 M_1(x_1, x_2) . \tag{3.3b}$$

That is, if both conditions are satisfied, then a dominant strategy for either a C-type or V-type legislator is to reject the initial amendment.

Given the nature of the amendment process, the probabilities will be weighted heavily toward small values of x_1 and x_2. The following assumption reflects this: there exists values x_1^b and x_2^b such that, for any proposal (x_1^0, x_2^0) and any initial amendment a_j^0, the support of f is contained in the set $= \{(x_1, x_2) : x_1[x_1^b, 0]$ and $x_2[0, x_2^b]\}$ and furthermore that $M_1(x_1^b, 0) < M_1(\hat{x}_1, \hat{x}_2)$ and $M_2(0, x_2^b) < M_2(\hat{x}_1, \hat{x}_2)$. Figures 3.4a and 3.4b clarify this assumption.

Given this assumption, the committee C can always construct a proposal (x_1^0, x_2^0) that yields positive returns to constituents of both C-type and V-type legislators—it can bargain with V— and at the same time can be defended on the floor. Formally, we have,

PROPOSITION 3.1:

There exists a neighborhood $N' \subseteq N$ (where N is as defined above) such that, for any $(x_1^0, x_2^0) \in N'$ and any a_j^0, conditions (3.3a) and (3.3b) will be satisfied.

Proof:

Let the initial proposal of C be $(\hat{x}_1, \hat{x}_2)$ and consider any a_j. By definition, $E^0 M_1(x_1, x_2) < M_1(x_1^b, 0)$ and $E^0 M_2(x_1, x_2) < M_2(x_1, x_2)$. From the above assumption it follows that $E^0 M_j(x_1, x_2) < M_j(\hat{x}_1, \hat{x}_2)$. Since M_j is continuous,this implies that for some subset of N, N', $E^0 M_j(x_1, x_2) < M_j(x_1^0, x_2^0)$ for any (x_1^0, x_2^0) in N'.

If legislators' preference functions are strictly concave in payoffs to constituents, i.e.,

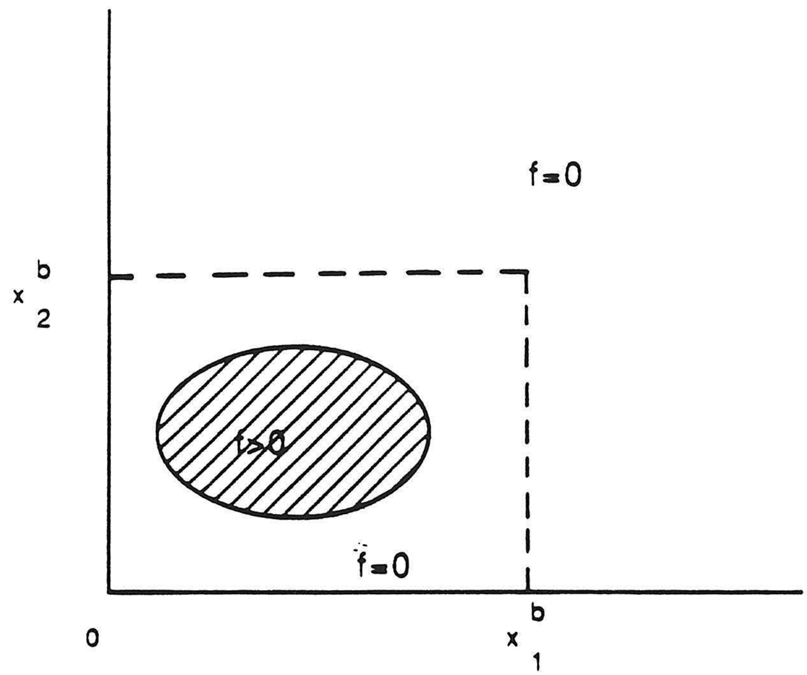


FIGURE 3.4 a

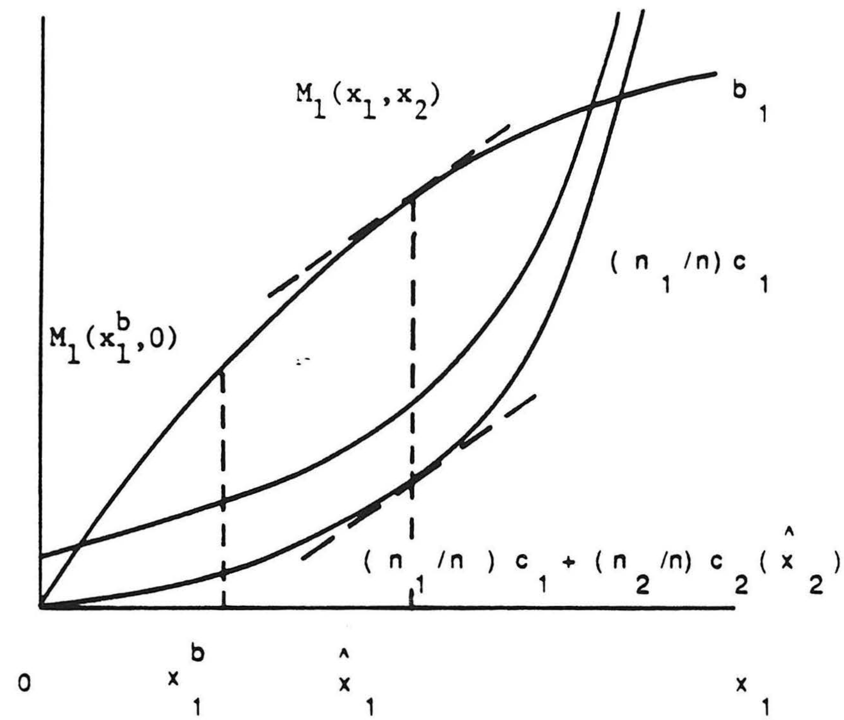


FIGURE 3.4 b

legislators are risk averse, then the necessary and sufficient conditions for a C-type or V-type to reject any amendment to the proposal are weaker:

$$u_j(M_j(x_1^0, x_2^0) > E^0 u_j(M_j(x_1, x_2)) \text{ for } j = 1, 2. \tag{3.4}$$

For similar reasons, germane amendments that scale up projects will tend to be voted down. Suppose, for instance, that an amendment $(0, a_2^1)$ is initially proposed. The scale of the V-type projects will be increased by a_2^1 if the amendment were accepted. The amendment would reduce the payoff to a C-type. Hence, it is equivalent to one which scales down the projects of the C-types and consequently would invite retaliatory measures from the C-types. Based on the preceding arguments, the V-types would be betteroff (in an expected value sense) with the initial bill (x_1^0, x_2^0) than with the probabilistic outcome of the retaliatory process. Hence, they would reject the amendment and thus keep the bill intact.

I now give two examples. First, consider the case $a_1^0 = -x_1^0$. That is, the initial amendment $(a_1^0, 0)$ deletes projects of C-type legislators from the proposal. This guarantees retaliation by C in the next stage with an amendment $(0, a_2)$ with $a_2 = -x_2^0$. Thus, both V-types and C-types are sure of the agenda implied by the initial amendment and so can vote sophisticatedly. I illustrate the game in Figure 3.5. Given the preferences of legislators, the sophisticated equivalent outcome at node 3 is (0, 0); that is, with probability one, the outcome under the implied amendment process is $M_1(0,0) = M_2(0,0) = 0$ which is less than $M_j(x_1^0, x_2^0)$. Thus, all legislators in $(C \cup V)$ will reject the initial amendment.

Next, consider the density function,

$$f(x_1, x_2; a_1^0, x_1^0, x_2^0) = \begin{cases} p^0, x_1 = x_1^*, \text{ and } x_2 = x_2^* \\ 1 - p^0, x_1 = x_2 = 0 \end{cases}$$

where $x_1^* \in (x_1^b, 0)$ and $x_2^* \in (0, x_2^b)$.

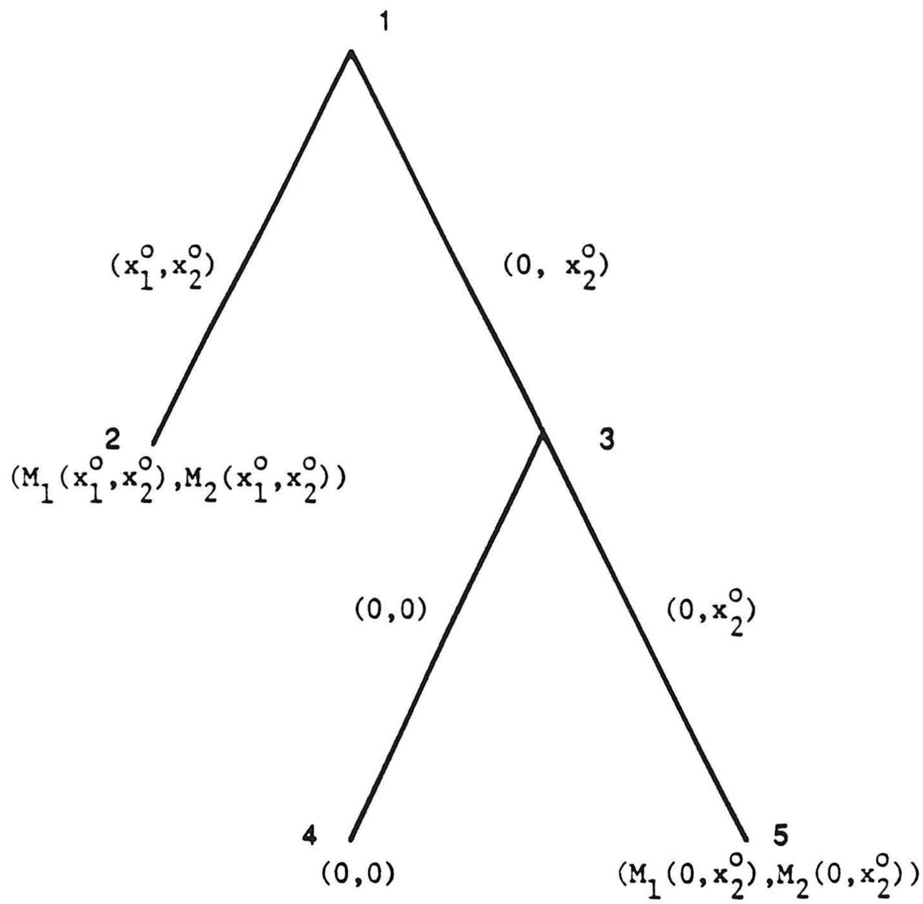

1
(x_1^o, x_2^o)
$(0,\ x_2^o)$
2
$(M_1(x_1^o, x_2^o), M_2(x_1^o, x_2^o))$
3
$(0,0)$
$(0, x_2^o)$
4
$(0,0)$
5
$(M_1(0, x_2^o), M_2(0, x_2^o))$

FIGURE 3.5

That is, the amendment process always results in either (x_1^*, x_2^*) or (0, 0) with their probabilities varying with the initial proposal and amendment. From the above proposition, C can always choose a proposal (x_1^0, x_2^0) such that,for any $a_1^0, M_1(x_1^0, x_2^{0)} > M_1(x_1^b, 0) > E^0M_1 = p^0M_1(x_1^*, x_2^*)$ and $M_2(x_1^0) > M_2(0, x_2^b) > E^0M_2 = p^0M_2(x_1^*, x_2^*)$. I depict this in Figure 3.6. Notice that if legislators are risk averse and if p^0 is always small—bounded above by some small number p sufficiently close to zero—then C can even choose a proposal $(\tilde{x}_1, \tilde{x}_2)$ that yields lower payoffs to constituents of legislators in $(C \cup V)$ without endangering the coalition; in other words, it has more leverage. In Figure 3.6, $K = \max\{pM_1(x_1^*, x_2^*)\}$.

So far I have assumed the S-types act independent of each other. I now turn to the situation in which they collude.

C. <u>Collusion by S</u>

Since they have been purposely excluded from the "spoils" by C, the S-types have an incentive to collude to try and derail the proposed winning coalition $(C \cup V)$. In the context of a closed rule, we assume they do this by offering the V-types the following counter proposal: if the V-types agree to reject C's proposal (x_1^0, x_2^0), the S-types will support a bill that contains only projects of the V-types, i.e., $(0, x_2^0)$. I of course assume V will propose such a bill if they agree to reject C's proposal.

The situation of a V-type is illustrated in Table 3.2. The E_k and v_l are interpreted similarly as in Table 1. As above, the payoffs to his constituents if E_1 or E_3 occur is the same regardless of how he votes, which implies he cannot be any worse off by choosing v_1. If E_2 occurs, however, his constituents stand to gain $m_{12} = M_2(x_1^0, x_2^0)$ if he supports C's proposed bill and some return m_{22} if he rejects it. Thus v_1 would be a dominant strategy for him if and only if $M_2(x_1^0, x_2^0) > m_{22}$. Now the value of m_{22} is probabilistic. A V-type can never be sure whether the S-types (or at least a sufficient number) will in fact support a bill $(0, x_2^0)$, since it is in the

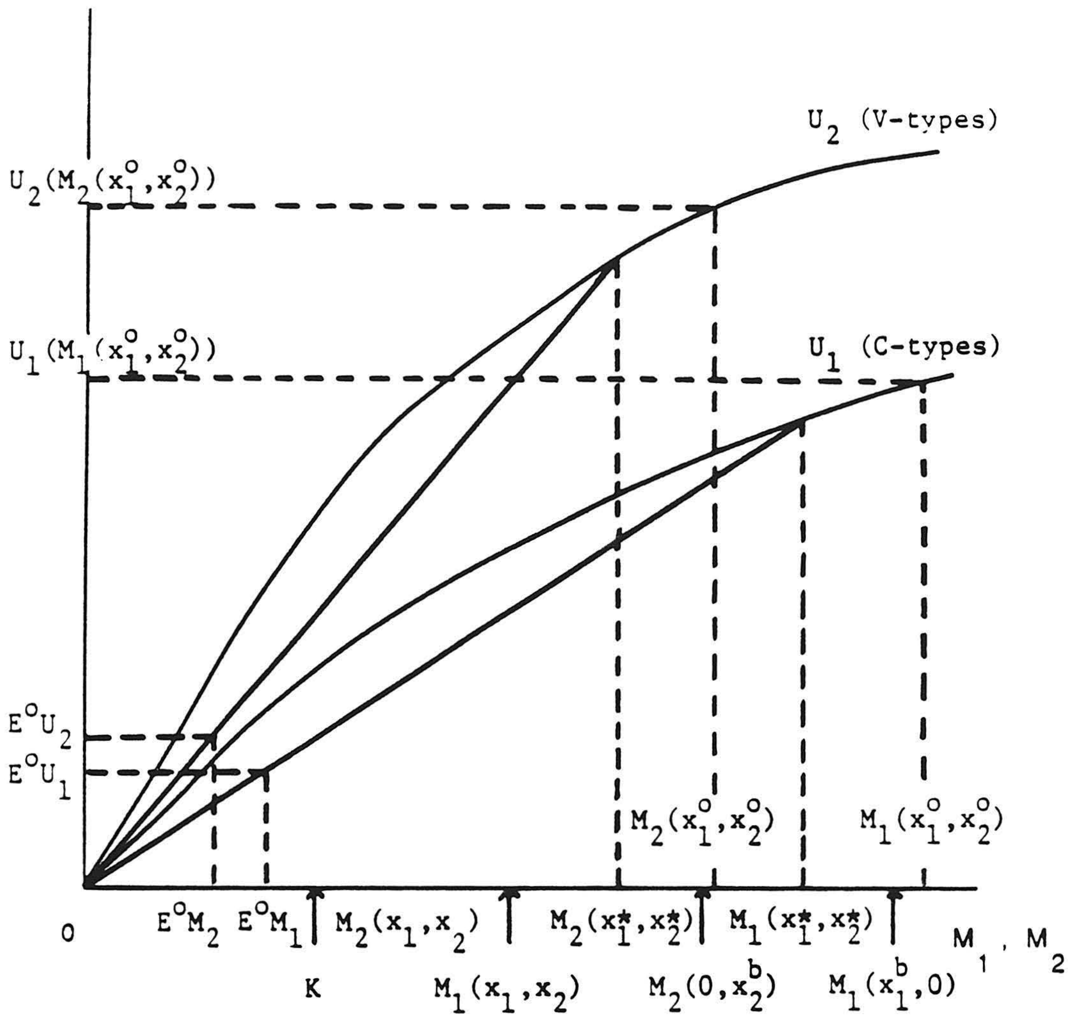

U2 (V-types)
U2(M2(x1o,x2o))
U1(M1(x1o,x2o))
U1 (C-types)
EoU2
EoU1
M2(x1o,x2o)
M1(x1o,x2o)
0
EoM2
EoM1
M2(x1,x2)
M2(x1*,x2*)
M1(x1*,x2*)
M1, M2
K
M1(x1,x2)
M2(0,x2b)
M1(x1b,0)

FIGURE 3.6

self interest of each S-type not to. Let q represent the probability that a sufficient number of S-types do vote for this bill given C's bill is rejected. Then $m_{22} = qM_2(0, x_2^0)$. It follows, then, that v_1 is a dominant strategy for a V-type legislator if,

$$b_2 - (1/n)(n_1c_1 + n_2c_2) > q\,[b_2 - (1/n)n_2c_2] \tag{3.4}$$

where the functions b_j and c_j are evaluated at (x_1^0, x_2^0),

or equivalently,

$$\frac{b_2 - (1/n)(n_1c_1 + n_2c_2)}{b_2 - (1/n)n_2c_2} > q\,. \tag{3.4'}$$ [8]

It follows then that if (3.4′) is satisfied, then C can defend the proposed bill, i.e., the proposed winning coalition.[9]

TABLE 3.2

	E_1	E_2	E_3
V_1	m_{11}	$m_{12} = M_2(x_1^0, x_2^0)$	m_{13}
V_2	m_{21}	m_{22}	m_{23}

Condition (3.4′) indicates the kind of leverage the committee has over the outcome. Define R as follows:

$$R \equiv \frac{b_2 - (1/n)(n_1c_1 + n_2c_2)}{b_2 - (1/n)n_2c_2} - q\,.$$

Notice that $\lim_{x_1 \to 0} R = (1 - q) > 0$. That is, by scaling down its own members' projects, the committee reduces the cost to a V-type of joining the coalition and thus increases his incentive to do so. If the cost is low enough, then the V-types would be induced to join and maintain the coalition. Hence, the committee can guarantee its members some positive payoff.

A somewhat counterintuitive result follows from (3.4′). Note that $\lim_{(n_1/n_2) \to 0} R = (1 - q)$: the smaller the committee is relative to the pivotal group, the greater its leverage over that group and thus the outcome. One would expect the opposite to be true. However, the result does make sense; the smaller the committee, the lower the cost and consequently the greater the incentive to the pivotal group for maintaining the coalition. Perhaps this is one reason why, for example, the Agricultural Committee in Congress, which is composed of a mere 35 legislators, has been modestly successful in obtaining favorable legislation via coalitions with urban congressmen (see Ferejohn, 1984, and Ripley, 1969).

There is an alternative interpretation of the committee's power. Condition (3.4) implies that the committee has the ability to pit a certain, favorable outcome against a risky, less favorable one. Let us assume that the preference function of a V-type legislator is strictly concave in net benefits to his constituents.[10] The function is illustrated in Figure 3.7 below. If E_2 occurs and a V-type legislator chooses v_2, his constituents get $[b_2 - (1/n)n_2c_2]$ with probability q and 0 with probability $(1-q)$. The expected return to his constituents is thus $q[b_2 - (1/n)n_2c_2]$ and his utility is $u_i = u_i(q[b_2 - (1/n)n_2])$. If instead the legislator chooses v_1, then his constituents get $[b_2 - (1/n)(n_1c_1 + n_2c_2)]$ for sure. Hence, by choosing x_1 such that $[b_2 - (1/n)(n_1c_1 + n_2c_2)]$ is between $q[b_2 - (1/n)n_2c_2]$ and $[b_2 - (1/n)n_2c_2]$, the committee can offer a V-type legislator a more favorable return with certainty, i.e., $u_1(b_2 - (1/n)(n_1c_1 + n_2c_2)) > qu_i(b_2 - (1/n)n_2c_2) + (1-q)0 = \bar{u}$.

Under a germaneness rule, the results are qualitatively the same except that now S immediately proposes an amendment $(a_1^0, 0)$ with $a_1^0 = -x_1^0$. Once again a V-type is faced with a choice between a certain and a risky outcome if his vote is pivotal. Since C is guaranteed to propose $(0, -x_2^0)$ in the next stage (in retaliation), then a V-type faces an uncertain outcome if he chooses v_2—$M_2(0, x_2^0)$ with probability q and 0 with probability $(1-q)$.

In conclusion, I have in effect identified certain conditions that could provide a committee with some bargaining power in shaping the character of policies within its jurisdiction, namely, authority over an extraneous policy and the ability to choose the composition of a potential

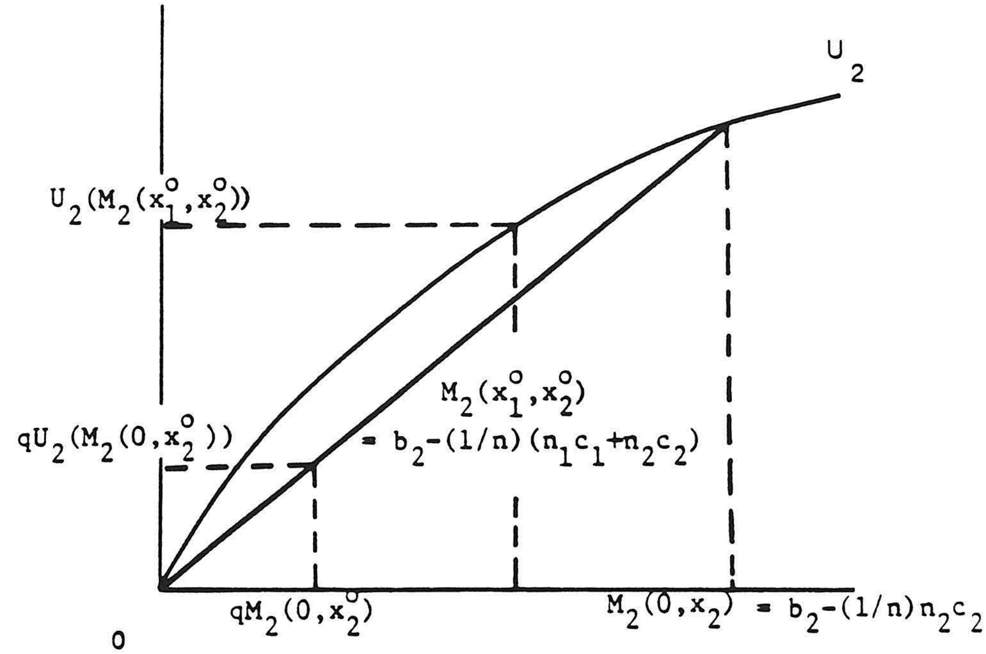

U 2
$U_2(M_2(x_1^o,x_2^o))$
$M_2(x_1^o,x_2^o)$
$= b_2-(1/n)(n_1c_1+n_2c_2)$
$qU_2(M_2(0,x_2^o))$
0
$qM_2(0,x_2^o)$
$M_2(0,x_2) = b_2-(1/n)n_2c_2$

FIGURE 3.7

winning coalition. The voting model I propose represents a real alternative to the Shepsle model.

FOOTNOTES TO CHAPTER 3

1. The Food Stamps Program is basically a welfare program targeted at the poor in urban areas and thus is not of much benefit to constituents of legislators in the Agricultural Committee. However, it provides nontrivial benefits to representatives from urban districts.

2. Ferejohn, 1984.

3. Note that $\{C, V, S\}$ is a partition of the legislature: let N represent the whole legislature; then $N = S \cup V \cup C$ and $C \cap V = C \cap S = S \cap V = \emptyset$.

4. This is a bit simplistic since it effectively requires that the members of V belong to a homogeneous group, e.g., urban Democrats. Certainly a committee is not limited to a choice of a single homogeneous group (see for instance Barton, 1976). However, rather than get hopelessly bogged down in a puddle of algebra, I feel it is more fruitful to simplify the model in this way.

5. Note that this does not preclude the possibility that $(b_j(\hat{x}_j) - c_j(\hat{x}_j)) < 0$, i.e., the project could be inefficient. If the initial endowment is rejected, then the net benefits to his constituents and thus his payoff is the same regardless of how he voted—$M_2(x_1^0, x_2^0)$; but if it is approved, then his payoff is probabilistic.

6. If the initial endowment is rejected then the net benefits to his constituents and thus his payoff is the same regardless of how he voted—$M_2(x_1^0, x_2^0)$; but if it is approved then his payoff is probabilistic.

7. We use a superscript "$_0$" to indicate that the expectation depends on the initial proposal and initial endowment.

8. We note two things in connection with this. First, one may invoke Axelrod's (1981) Tit-for-Tat argument to reject this assertion. However, his argument implicitly assumes that the same participants will continue playing the repetitive game for a considerable length of time. This is too strong. There is no guarantee that an S-type will still be around in the near future. Secondly, V may choose to propose a different bill $(0, x_2)$. In this case we can let $w(x_2) = \{x_2^* : x_2^* < x_2\}$ and $H^0(x_2) = prob(w(x_2))$ occurs given C proposes (x_1^0, x_2^0) with density h^0. Quite clearly, there is some $z_2^0 = x_2(x_1^0, x_2^0)$ such that $(n_2/n)c_2(z_2^0) = (1/n)[n_1c_1(x_1^0) + n_2c_2(x_2^0)$. This implies that an S-type will never agree to a bill $(0, x_2)$ if $x_2 > z_2^0$; hence, the support of h^0 is contained in $[0, z_2^0]$. A V-type will support C's proposal if,

$$M_2(x_1^0, x_2^0) > E_2^0 M_2(0, x_2) = \int_0^{z_2^0} P_2(x_2)h^0(x_2)dx_2 \qquad (3F.1)$$

It can easily be shown that a sufficient condition for C to be able to construct a proposal satisfying (3F.1) is, for all x_2,

$$M_2(\tilde{x}_1, x_2) > \int_0^{z_2} P_2(x_2)h(x_2)dx_2 \qquad (3F.2)$$

where $\tilde{x}_1$ satisfies $M_1(\tilde{x}_1, \hat{x}_2) = 0$, $z_2 = x_2(\tilde{x}_1, \hat{x}_2)$,
and h is conditional on $(x_1 = \tilde{x}_1, x_2 = \hat{x}_2)$.

In Figure 3F.1 I describe graphically how $\tilde{x}_1$ is derived, and in Figure 3F.2 I illustrate (3F.2). Note that condition (3F.2) is roughly equivalent to condition (3.4) in the text.

9. If the preference of a V-type is linear in payoffs (M_2), then the condition is both necessary and sufficient.

10. Peltzman (1976) and Shepsle, Weingast, and Johnsen (1981) make essentially the same assumptions.

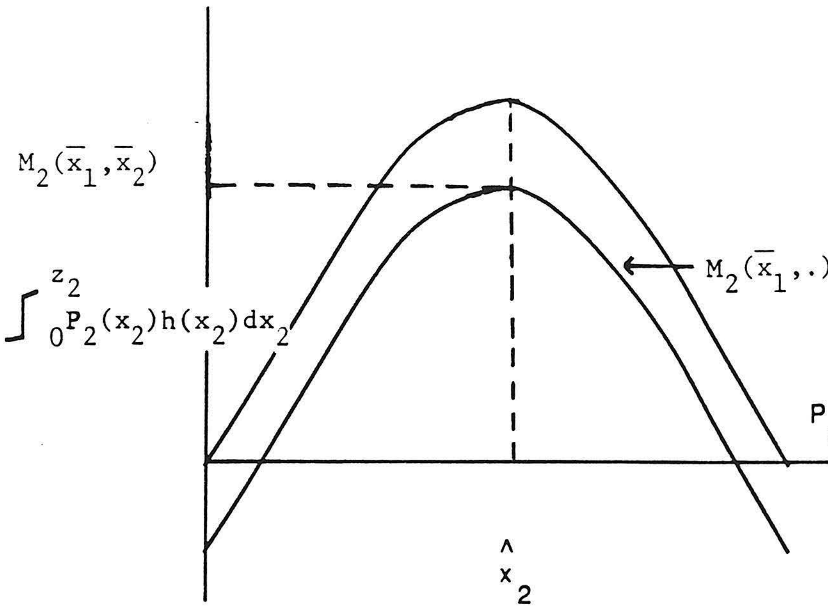


FIGURE 3F.1

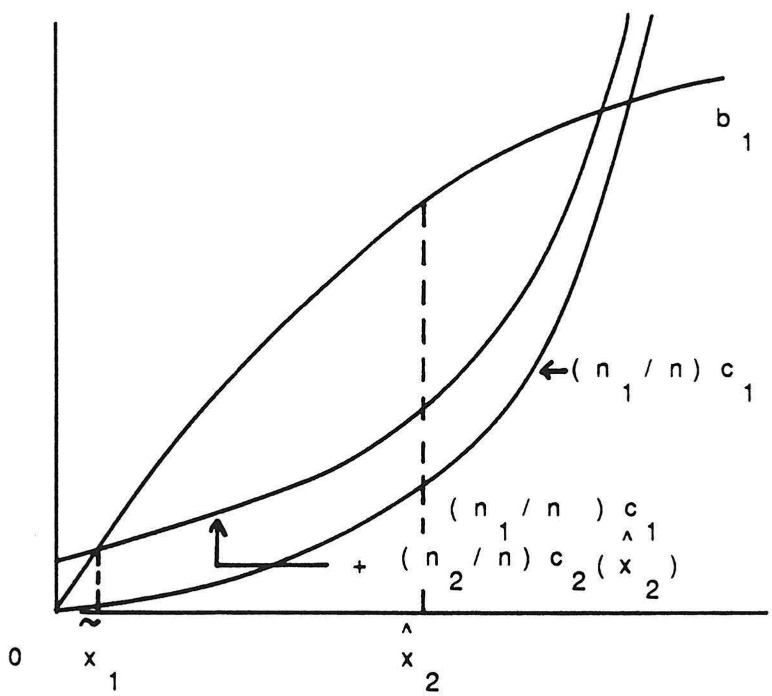


FIGURE 3F.2

CHAPTER 4

A PROPOSED MODEL OF PRICE SUPPORTS

In the last chapter, I discussed two models that political scientists would most likely use to analyze price support legislation. I criticized them for certain weaknesses which ultimately keep them from providing a complete mapping from legislator's preferences to policy outcomes. In this section I develop a simple, formal model that provides a better picture of this mapping.

Specifically, I will integrate economic factors, political factors, and key Congressional institutions into an institutionally rich collective decision-making model. As implied, I will assume a representative form of government in which legislation is decided by representatives of political regions who in turn are elected by inhabitants of their respective regions via majority vote. I will also assume that a representative's main objective is to get re-elected and thus to maximize votes. To facilitate the discussion, I will refer to representatives as legislators, to political regions as districts, and to its inhabitants as constituents. Furthermore, I will denote the commodity to be supported by $com(k)$ and assume the free market (no price support) as the status quo.

As argued in chapter one, price supports do not serve the public interest. They create inefficiencies and so are economically unjustifiable. But why, then, do we observe price supports? The seemingly obvious answer is that price supports are the product of political and not economic markets. However, given that legislators maximize votes and that producers of the supported commodity constitute a very small proportion of the total population, this would seem perplexing. My objective is to identify those features that generate this seemingly improbable outcome and fuse them into a coherent model.

A. <u>A Legislator's Objective Function</u>:

In any arbitrary district j, producers of $com(k)$ base their decision to vote for or against (incumbent) legislator j on their gain from the price support. Under the status quo, a certain proportion of producers, denoted h^j, will vote for the legislator.[1] Let $G(\bar{p})$ be the aggregate gain to producers and $L(\bar{p})$ the aggregate loss to consumers if an effective price support $\bar{p}$ is adopted, and let W and N be the total number of producers and consumers respectively. With an effective price support $\bar{p}$ that yields a per capita gain $\bar{G}(\bar{p}) = (1/W)(G(\bar{p}))$, an additional proportion $\delta_w^j(G(\bar{p}))$ will vote for him. Thus, if a legislator draws randomly from the whole set of producers in his district, the probability that that producer will vote for him is $[h^j + \delta_w^j(G(\bar{p})]$ given that a price support of $\bar{p}$ is implemented. In other words, $[h^j + \delta_w^j(G(\bar{p})]$ is the probability that a producer in district j will vote for the legislator given a price support $\bar{p}$ is implemented.

Similarly, a certain proportion of consumers in district j, denoted f^j, will vote for legislator j given the status quo. Since an effective price support $\bar{p}$ results in a corresponding per capita loss $\bar{L}(\bar{p}) = (1/N)(L(\bar{p}))$, some proportion of these consumers, $\delta_l^j(\bar{L}(\bar{p}))$, will vote against the legislator if $\bar{p}$ is implemented. Hence, $[f^j + \delta_l^j(\bar{L}(\bar{p}))]$ can be interpreted as the net probability that a consumer in district j will vote for his legislator if $\bar{p}$ is implemented.[2]

To sum up, then, the probability vote function of a producer in district j is given by

$$\Psi_j(\bar{G}(\bar{p})) = h^j + \delta_w^j(\bar{G}(\bar{p}))$$

and of a consumer by,

$$\Phi_j(\bar{L}(\bar{p})) = f^j - \delta_l^j(L(p)) .$$

A legislator is assumed to maximize expected votes. Let $Q_j(\bar{p})$ denote his net expected votes if a price support p is implemented. Define the (Bernoulli) random variables X_w and X_l as follows:

$$X_w = \begin{cases} 1, \text{ if a producer votes for the legislator} \\ 0, \text{ otherwise} \end{cases}$$

$$X_l = \begin{cases} 1, \text{ if a consumer votes for the legislator} \\ 0, \text{ otherwise} \end{cases}$$

Let W_j be the number of $com(k)$ producers and N_j the number of consumers in district j. Then,

$$\begin{aligned} Q_j(p) &= W_j Prob(X_w = 1) + N_j Prob(X_1 = 1)^3 \\ &= W_j \delta_w^j(\bar{G}(\bar{p})) + N_j \delta_l^j(\bar{L}(\bar{p})) \end{aligned}$$

$$= W_j[h_j + \delta_w^j(G(p))] + N_j[f^j - \delta_l^j(L(p))]$$
$$= [W_j h^j + N_j f^j] + [W_j \delta_w^j(\bar{G}(\bar{p})) - N_j \delta_l^j(\bar{L}(\bar{p}))] \,.$$

Since $(W_j h^j + N_j f^j)$ is independent of p, it can be disregarded. For simplicity then I will let expected votes be represented by

$$Q_j(\bar{p}) = W_j \delta_w^j(\bar{G}(\bar{p})) - N_j \delta_l^j(\bar{L}(\bar{p})) \,. \tag{4.1}$$

The functions δ_w^j and δ_l^j are assumed to satisfy the following properties:

(i) $\delta_w^j(0) = \delta_l^j(0) = 0$,

(ii) $\delta_w^{j'} > 0$ and $\delta_w^{j''} < 0$,

(iii) $\delta_l^{j'}, \delta_l^{j''} > 0$,

(iv) $\lim_{\bar{G} \to \infty+} \delta_w^{j'} = 0$, and

(v) $\lim_{\bar{L} \to \hat{L}} \delta_l^{j'} = \infty+$ where $\hat{L} = sup\{\bar{L} : 0 \le \delta_l^j(\bar{L}) \le f^j\}$.

The last two properties are merely meant to convey that beyond some point additional gains would be negligible to the legislator, and additional losses would be prohibitive. Figures 4.1a and 4.1b depict these functions.

Let p^* be the free market equilibrium price and assume that a maximum price exists— there is a price p_m such that $f_k(p_m) = 0$ where $f_k(p_m) = 0$ is the demand function for $com(k)$. Then the policy relevant price support levels are those between p^* and p_m. A support level below p^* such as p_L in Figure 4.2 below is ineffective; on the other hand, a support above p_m such as p_U is no better than p_m, i.e., $f_k(p_U) = f_k(p_m) = 0$. Now since $G(p^*) = L(p^*) = 0$ and $\delta_w^j(0) = \delta_l^j(0) = 0$ then $\max_{\mathbb{B}} Q_j(\bar{p})$ where $\mathbb{B} = \{\bar{p} : p^* \le p \le p_m\}$ must be non-negative. Hence, if $Q_j(\bar{p}) \le 0$ for all p in $\mathbb{B}$, then legislator j will oppose the adoption of a price support. On the

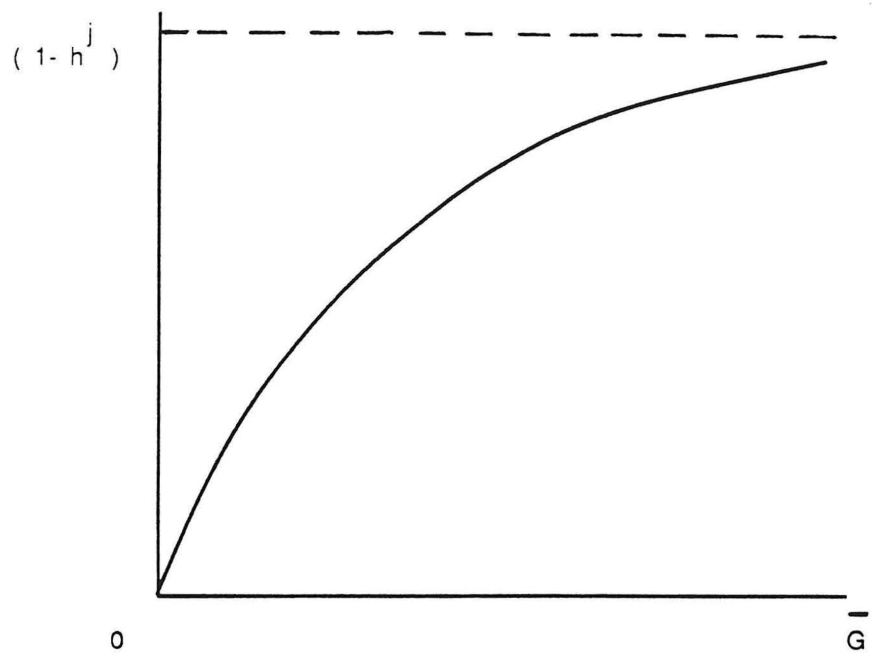


FIGURE 4.1 a

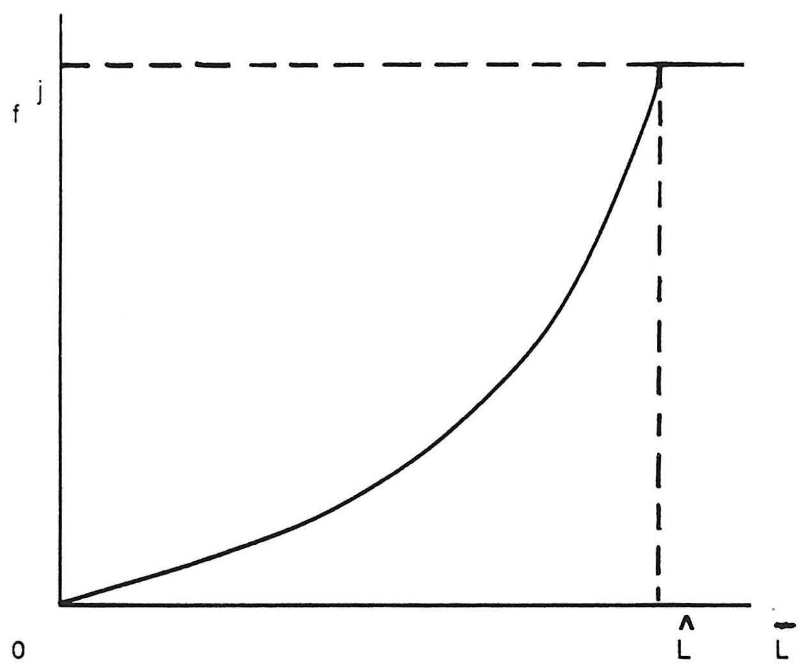


FIGURE 4.1b

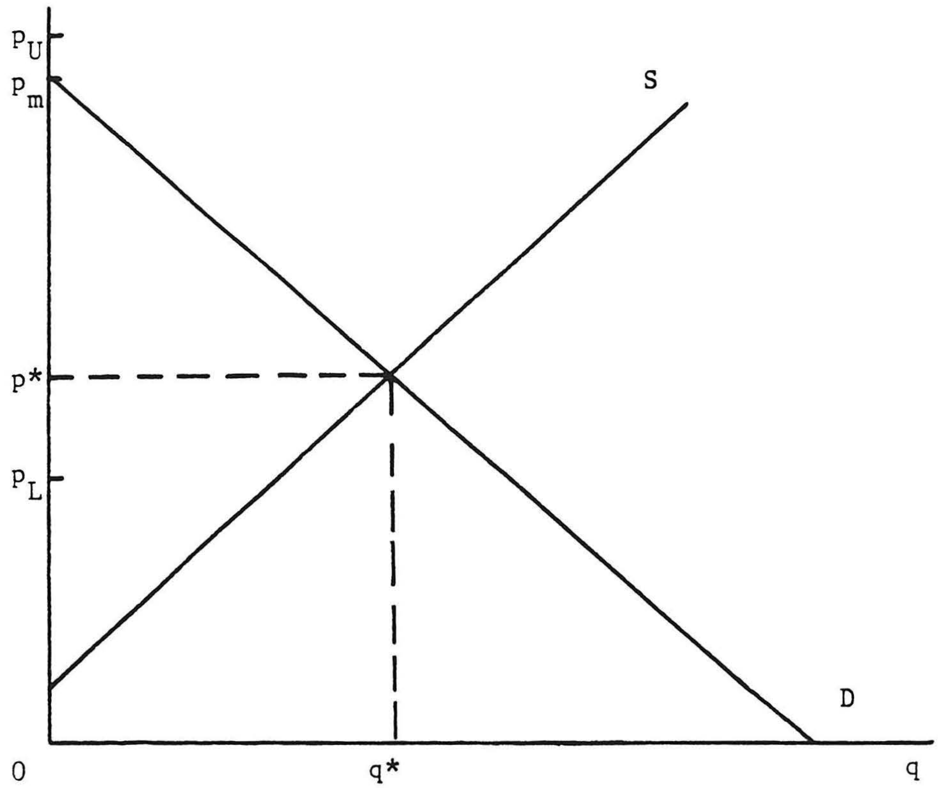


FIGURE 4.2

other hand, if there exists a p in $\mathbb{B}$ such that $Q_j(\bar{p}) > 0$,then legislator j may be willing to support the adoption of a price support if the support level is within a sufficient neighborhood of p. I will expound on this in the next section, but before doing so let me discuss how interest groups fit into the scheme of things.

Political markets are characterized by competition between interest groups for favorable outcomes. The more influential groups benefit, while the less influential lose. The smaller the size of a group and to some extent the more concentrated the location of its members, the lower its organizational costs. Also, the larger (smaller) the per capita benefit to a group from a favorable outcome, the more (less) likely the group can gain from organizing. Both these factors provide incentives for the group to organize and thus yield political influence. That is, the group membership would be better able to effectively lobby their legislators.

In the context of the model, producers of $com(k)$ can be thought of as one interest group, e.g., wheat farmers, and consumers another. In general, producers would have organizational advantages. They are much fewer than consumers. Furthermore, they tend to be geographically concentrated. On the other hand, consumers tend to be widely scattered. Consequently, organizational costs of producers will tend to be lower. Furthermore, the benefits of a price support are concentrated on producers and its costs diffused across a much larger number of consumers. Hence, the potential per capita benefit to producers is much larger than that which could accrue to consumers, giving the former more incentive to organize. In short, producers will tend to be much better organized and better able to lobby their legislators.

The impact of producers and consumers as interest groups can be accommodated into the model by assuming simply that the functions δ_w^j and δ_f^j reflect in part the organizational characteristics of each group.

B. <u>Properties of the Objective Function</u>:

Suppose the objective function $Q_j(\cdot)$ is strictly concave. Then it is necessarily single peaked. Single peakedness is defined as follows.

DEFINITION 4.1:

The function Q_j is said to be single peaked if there exists a $p_j \in [p^*, \infty+)$ such that for any $\bar{p} \in \mathbb{B}\ \{p_j\}$ and $\lambda \in (0, 1]$, $Q_j(\lambda p_j + (1-\lambda)\bar{p}) > Q_j(\bar{p})$. The following proposition establishes the above claim.

PROPOSITION 4.1:

Let $Q_j'' < 0$ for all $\bar{p} \in (p^*, \infty+)$. Then Q_j is single peaked in $\mathbb{B}$.

Proof:

Since $\mathbb{B}$ is compact there exists a $\hat{p}_j \in \mathbb{B}$ such that $Q_j(\hat{p}_j) \geq Q_j(\bar{p})$ for all $\bar{p} \in \mathbb{B}$. Now either $\hat{p}_j \in int(\mathbb{B})$, $\hat{p}_j = p^*$, or $\hat{p}_j = p_m$. Suppose $\hat{p}_j \in int(\mathbb{B})$. By Taylor's theorem, for any $\bar{p}$,

$$Q_j(\bar{p}) = Q_j(\hat{p}_j) + Q_j'(\hat{p}_j)(\bar{p} - \hat{p}_j) + (1/2)Q_j''(\bar{\bar{p}})(\bar{p} - \hat{p}_j)^2$$

where $\bar{\bar{p}}$ is between $\hat{p}_j$ and $\bar{p}$. Since $\hat{p}_j \in int(\mathbb{B})$ then $Q_j'(\hat{p}_j) = 0$. Given $Q_j'' < 0$ for all $\bar{p}$ then $Q_j(\bar{p}) - Q_j(\hat{p}_j) < 0$ provided $\bar{p} \neq \hat{p}_j$. Now choose any p and $\lambda \in (0, 1]$ and set $\bar{p} = \lambda p_j + (1-\lambda)p$, then it follows that $\hat{p}_j = p_j$ (see Definition 4.1). Suppose $\hat{p}_j = p^*$, then $Q_j(p^*) \geq Q_j(\bar{p})$ for all $\bar{p} \in \mathbb{B}$. Now, given the hypothesis, it must be the case that p^* is the unique maximizer. If it were not, then by definition there exists some other price $\tilde{p}$ such that $Q_j(\tilde{p}) = Q_j(p^*)$. Once again using Taylor's expansion,

$$Q_j(p^*) = Q_j(\tilde{p}) + Q_j'(\tilde{p})(p^* - \tilde{p}) + (1/2)Q_j''(\bar{\bar{p}})(p^* - \tilde{p})^2.$$

Since $Q_j'(\tilde{p})$ must be zero, then $Q_j(p^*) < Q_j(\tilde{p})$, which is a contradiction. Hence, $Q_j(p^*) > Q_j(\bar{p})$ for all $\bar{p} \in \mathbb{B}$ with $\bar{p} \neq p^*$. Again, for any $p \in \mathbb{B}$ and $\lambda \in (0, 1]$ set

$\bar{p} = \lambda p^* + (1-\lambda)p$. This same line of reasoning can be applied to the case $\hat{p}_j = p_m$. □

Henceforth, I will assume Q_j is strictly concave.[4] I should note that strict concavity is not necessary for single-peakedness. Strict quasi-concavity is all that is needed. However, the former is useful in deriving comparative static results.

Given Q_j is strictly concave, legislators can be classified into three categories:

(I) Those with peaks at the left border of the feasible set: $Q_j(\bar{p}) < Q_j(p^*)$ for all $\bar{p} \in \mathbb{B}\ \{p^*\}$.[5]

(II) Those with peaks in the interior of the feasible set: $Q_j'(p_j) = 0$ for $p_j \in int(\mathbb{B})$.

(III) Those with peaks at the right border of the feasible set: $Q_j(\bar{p}) < Q\,(p_m)$ for all $\bar{p} \in \mathbb{B}\ \{p_m\}$. I depict these in Figure 4.3.

Most legislators will fall under category II and probably none under category III. Only those legislators who represent districts with a *relatively* large number of $com(k)$ producers will fall under the second category. The next proposition clarifies this point.

PROPOSITION 4.2:

Let $(W_j \delta_w^{j'} G'|_{\bar{p}=p^*}) > (N_j \delta_l^{j'} L'|_{\bar{p}=p^*})$. Then $p_j > p^*$.

Proof:

Suppose we assume otherwise, i.e., $p_j = p^*$. Now the hypothesis implies that $Q_j'(p^*) > 0$. If $Q_j(p^*) = 0$ then there exists some $\varepsilon > 0$ such that $Q_j(p^* + \varepsilon) > Q_j(p^*)$. But this means $p_j > p^*$ which is a contradiction. □

The hypothesis of this proposition requires that the marginal gain in votes from producers exceeds the marginal loss in consumer votes at the free market price. In plain language it means legislator j can gain votes supporting a price support level sufficiently close to the free market level. Certainly this condition would likely be satisfied in districts with a *relatively* high

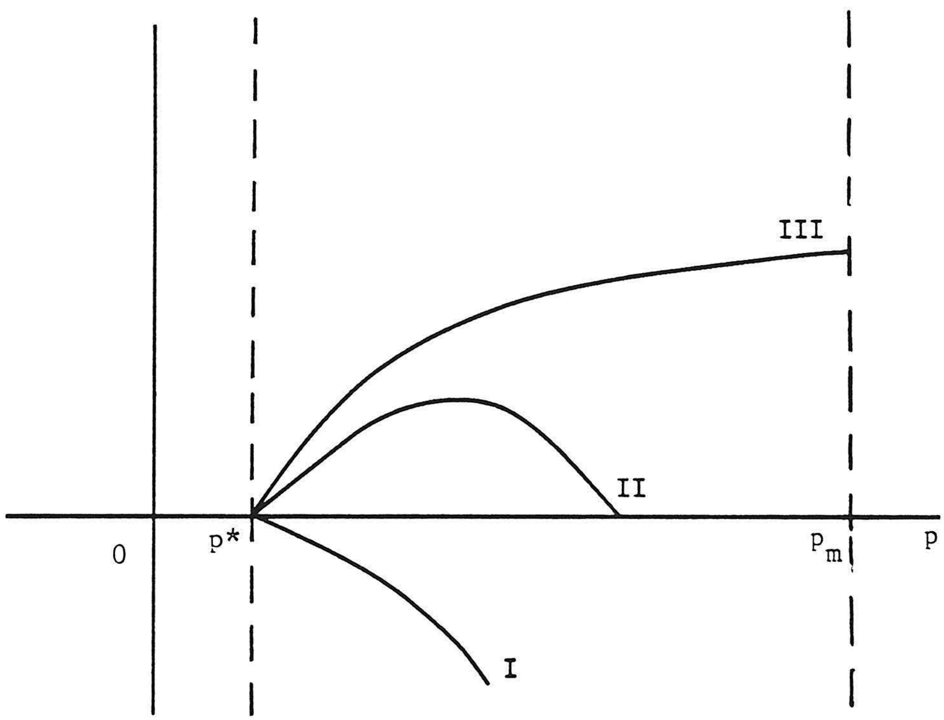


FIGURE 4.3

proportion of $com(k)$ producers.

C. Institutional Framework:

Each legislator represents voters from a given district. Decisions on policies are hammered within a legislative body, e.g., Congress, with each legislator trying to obtain the most for his constituents. Unless certain restrictions are imposed on the decision-making process, chaos would result (see for instance, McKelvey, 1976). To guarantee a well-behaved decision process, I will assume that the legislative body is disaggregated into committees and committees into subcommittees and that each committee is granted authority over a subset of policies. I describe these restrictions formally below.

Let $\mathbf{L}$ represent the legislative body and T the number of legislators, i.e., $\mathbf{L} = \{1, \ldots, j, \ldots, T\}$. Let $\mathbf{J}$ be the set of all areas of major legislation and denote an element of $\mathbf{J}$ as a jurisdiction. Finally, let $\mathbf{L}^S$ be the set of all possible subsets of $\mathbf{L}$. I will assume there exists a correspondence $F_1 : \mathbf{L} \rightarrow \mathbf{L}^S$ such that $F_1(\mathbf{L})$ is a finite cover of $\mathbf{L}$ and a surjection[6] $F_2 : F_1(\mathbf{L}) \rightarrow \mathbf{J}$ that defines the administrative setup of the body. The correspondence F_1 assigns each legislator to one or more subgroups, to be called committees, and the correspondence F_2 makes each committee responsible for a certain subset of jurisdictions.

Let $J_{P(k)}$ represent the price support issue involving $com(k)$ and let $\mathbf{K}$ be the set of all commodities being considered for price supports with K the total number of such commodities. I will assume that there exists a $C_p \in F_1(\mathbf{L})$ such that $F_2(C_p) = \{J_{p(k)}\}_{k=1}^{K}$ and $F_2^{-1}(\{J_{p(k)}\}_{k=1}^{K}) = C_p$. Furthermore, I will assume there exists a correspondence $F_3 : C^p \rightarrow C_p^s$ where C_p^s is the set of all possible subsets of C_p and $F_3(C^p)$ is a finite cover of C_p and a one-to-one function $F_4 : F_3(C_p) \rightarrow \{J_{p(k)}\}_{k=1}^{K}$ that define the division of labor among members of C_p. In other words, F_3 divides C_p into subcommittees while F_4 assigns each subcommittee to a single price support issue and guarantees that some subcommittee will be responsible for each price support issue. Note that since F_4 is one-to-one, there are exactly K subcommittees, each corresponding to exactly one commodity. If F_3 is restricted to being a function, then the K subcommittees are disjoint. That is, each is responsible for exactly one commodity—a one-dimensional issue subspace.

Lastly, let $C^k \in F_3(C_p)$ and let $|C^k|$ be the number of legislators in C^k. I will assume that there are at least $[(|C^k| + 1)/2]$ legislators in C^k such that $[W^j \delta_w^{\prime} \bar{G}^{k\prime} - N_j \delta_l^{\prime} \bar{L}^{k\prime}]|_{\hat{p}=p^*} > 0$[7]; G^k and L^k are the gain and loss functions with respect to commodity k. Referring to proposition 4.2, this means that the division of labor in the legislative body is such that a majority of legislators who comprise a given subcommittee in C^k are precisely those who would benefit electorally from favorable legislation on the price support issue for which the subcommittee is responsible.

I should point out that I am implicitly assuming that each district has, at most, one supported commodity. If more than one commodity is supported, the results remain valid, provided producers of each supported commodity help or at least do not interfere in the cause of producers of the other supported commodities.

D. <u>The Existence of a Conditional Voting Equilibrium</u>:

Given the the objective functions of legislators, the assumed committee system, and the specified jurisdictional arrangements, there will be a conditional and nondegenerate subcommittee voting equilibrium. Since Q_j is single peaked in $\hat{p}$, and each subcommittee in C_p has a single jurisdiction, then by Black's theorem a subcommittee (voting) equilibrium price support level will exist. The equilibrium is the median voter's optimal choice of support level. It is nondegenerate since, as implied above, the median voter's choice will exceed the free market price. It is conditional because it depends on the method chosen to support price. I will have more to say on the choice of methods in later chapters; for now, I assume that some method or instrument i has been adopted.

Formally, a conditional subcommittee equilibrium is defined in the following way. Let C be the set of legislators in a subcommittee and $|C|$ the number therein. Let C' be a coalition in

C and $|C'|$ the number of legislators in C'. C' is said to be a winning coalition in C if $|C'| > (|C|/2)$.[8] Now let i represent the adopted instrument and let p^i be a price support level under i. Then p^i is said to dominate p^i within the subcommittee if there exists a winning coalition in the subcommittee, C', such that all members of C' prefer $p^{i'}$ to p^i.

DEFINITION 4.2:

A conditional subcommittee equilibrium is a pair $(i, \hat{p}^i)$ such that $\hat{p}^i \in \mathbb{B}$ and $\hat{p}^i$ dominates every other $p^i \in \mathbb{B}$.

The next proposition formalizes the above claim.

PROPOSITION 4.3:

For any i, there exists a $\hat{p}_i$ such that $(i, \hat{p}_i)$ is a conditional subcommittee equilibrium.

The question that comes to mind at this point is whether a conditional voting equilibrium for the whole legislative body exists. In chapter 3, I argued that under certain conditions a committee will have some bargaining power to extract a favorable outcome over policies that affect its members' constituents. If one assumes that the subcommittees within the committee simply accept each other's recommendations, then committee bargaining power implies that some nondegenerate support level will be chosen by the whole body for each of the commodities. What this means, of course, is that effective price supports will be implemented even if they create inefficiencies.

To be more specific, assume then that $(i(k), \tilde{p}^{i(k)})$ is the k^{th} subcommittee's conditional voting equilibrium—its recommendation. Assume further that the committee C_p has some bargaining power indexed by $\mu \in (0, 1)$. This implies a final outcome for each commodity k, $\{(i(k), (1-\mu)p^{k*} + \mu\tilde{p}^{i(k)}\}$, in which $((1-\mu)p^{k*} + \mu\tilde{p}^{i(k)}) > p^*$ for each k. Hence, a conditional voting equilibrium exists and is nondegenerate. Figure 4.4 illustrates this for the case of $K = 2$ and a given choice of instruments.

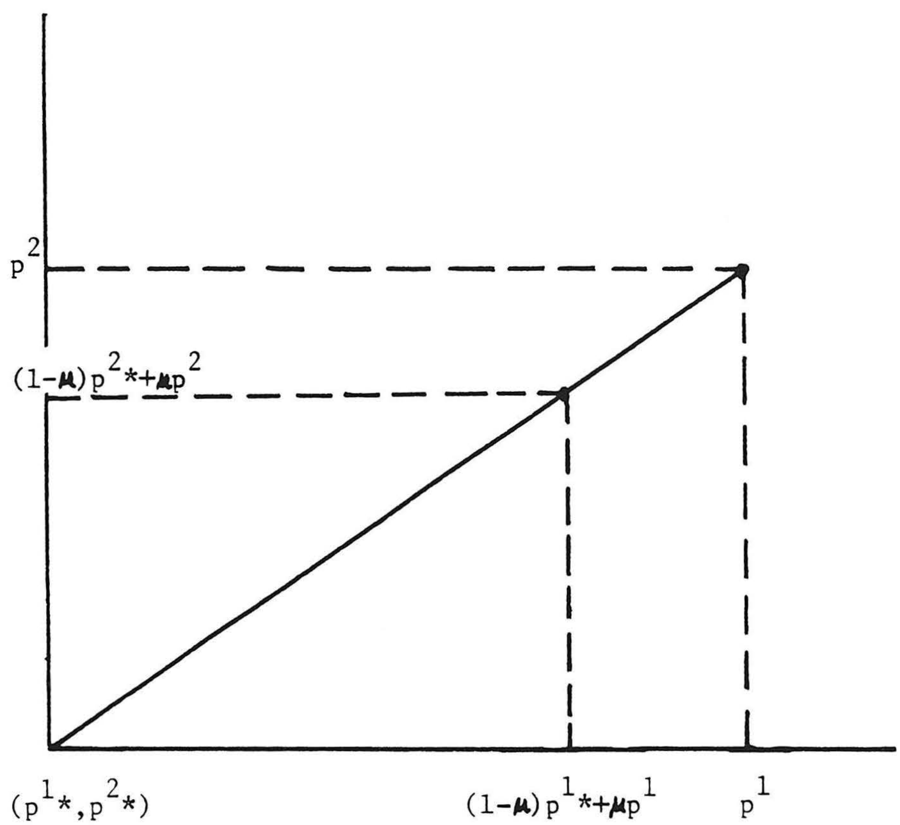


FIGURE 4.4

To recapitulate, then, I have created an institutionally rich voting model that provides a possible explanation for the existence of price supports. The elements of the model—committee/subcommittee system, an underlying assignment process, a jurisdictional arrangement across committees and subcommittees, some implicit committee bargaining power, and vote maximization—interact with economic private gains and losses to produce politically feasible outcomes favorable to producers, i.e., effective price supports. In the next section I will explore the relationships between vote outcomes and various economic and political parameters, using the familiar technique of comparative statistics, and will then test hypotheses about these relationships using data from the feed grains market.

E. <u>Some Comparative Statics Results</u>:

As implied above, for any instrument i, there is some support level that a legislator will prefer to all other feasible choices. This optimal level, denoted $\hat{p}_j^1$, maximizes his objective function conditional on instrument i. Denote the conditional objective function by $Q_{j,i}$. Then, p_j^i satisfies.br

$$Q_{j,i}'(\bar{p}) = W_j \delta_w^{i'} \bar{G}_i'(\bar{p}) - N_j \delta_L^{i'} \bar{L}_i'(\bar{p}) = 0\ .^9 \tag{4.2}$$

And, since $Q_{j,i}$ is strictly concave, $\hat{p}_j^i$ is unique. Furthermore, it depends on both political and economic parameters, i.e., $\hat{p}_j^i = \hat{p}_j^i(\mu_j)$ where μ_j is a vector of parameters. Let m be a scalar parameter (in μ_j) then, from the implicit function theorem,

$$\frac{\partial \hat{p}_j^i}{\partial m} = - \frac{(\partial Q_{j,i}'/\partial m)}{Q_{j,i}''}\ . \tag{4.3}$$

Since $Q_{j,i}'' < 0$, then the sign of $(\partial \hat{p}_j^i/\partial m)$ is the same as the sign of $(\partial Q_{j,i}'/\partial m)$. I will use this result to predict the response of a legislator—whether he prefers a higher or lower support level—to changes in selected parameters.

E.1 <u>A Change in Composition of the Constituency</u>:

The following proposition indicates how a legislator will respond to a change in the composition of his constituency (say, due to redistricting). Specifically, it states that he will favor lowering the support level if the number of consumers in his district increases relative to the number of producers. It also implies that the median legislator and thus the legislative body will desire a lower level. That is,

$$\frac{\partial}{\partial N_j}\left[(1-\mu)p^{k*} + \mu\tilde{p}^{\,i(k)}\right] = \mu\frac{\partial \tilde{p}^{\,i(k)}}{\partial N_j} < 0$$

since $\tilde{p}^{\,i(k)}$ is the median legislator's optimal choice. In general, this result is invariant with respect to the instrument adopted.

PROPOSITION 4.4:

For any instrument i, $(\partial \hat{p}_j^i / \partial N_j) < 0$.[10]

Proof:

$(\partial Q'_{j,i} / \partial N_j) = -\delta_i' \bar{L}_1' (\hat{p}^j) < 0.$

In order to analyze the impact of economic parameters on a legislator's optimal choice, one must know which instrument is to be used. An instrument yields a specific gain to producers and loss to consumers, which is generally different from another instrument's. I will have more to say on this in chapter six. For my purposes, I will assume that a price floor is the designated instrument.

E.2 <u>An Improvement in Technology</u>:

In chapter six I will explain in detail what a price floor is. For now, suffice it to say that, assuming demand is linear—$f(p) = d - cp$—and supply is linear—$h(p) = a + bp$—then under a price floor, the aggregate gain is represented by,

$$G(\bar{p}) = (a\bar{p} + (b/2)\bar{p}^2) - (ap^* + (b/2)p^{*2})$$

and the aggregate loss by,

$$L(\bar{p}) = (b + (c/2))\bar{p}^2 + (a + (b + c)s)\bar{p} - (d - a)s - (dp^* - (c/2)p^{*2})$$

where s is the cost of storing a unit of excess production.[11] The next proposition shows how the optimal support level changes under a price floor in response to technological improvements. A change in technology is represented by a downward parallel shift in the supply curve, i.e., an increase in the value of a. The optimal level falls as new technology is adopted, provided supply is not too elastic.

PROPOSITION 4.5:

Let i be a price floor. Then, there exists a $\gamma > 0$ such that for all $b \in (0, c + \gamma)$, $(\partial \hat{p}_i^i / \partial a) < 0$.

Proof:

First note that

$$\begin{aligned}\frac{\partial Q_{j,i}'}{\partial a} &= M_j\left[\delta_w^{j\prime}\frac{\partial \bar{G}_i'}{\partial a} + \delta_w^{j\prime\prime}\frac{\partial \bar{G}_i}{\partial a}\bar{G}_i'\right] - N_j\left[\delta_l^{j\prime}\frac{\partial \bar{L}_i'}{\partial a} + \delta_l^{j\prime\prime}\frac{\partial \bar{L}_i}{\partial a}\bar{L}_i'\right] \\ &= \left[M_j\delta_w^{j\prime}\frac{\partial \bar{G}_i'}{\partial a} - N_j\delta_l^{j\prime}\frac{\partial \bar{L}_i'}{\partial a}\right] + \left[M_j\delta_w^{j\prime\prime}\frac{\partial \bar{G}_i}{\partial a}\,G_i' - N_j\delta_l^{j\prime\prime}\frac{\partial \bar{L}_i}{\partial a}\bar{L}_i'\right].\end{aligned}$$

From above, $(\partial \bar{G}_i / \partial a) > 0$, $(\partial \bar{L}_i / \partial a) > 0$, $\bar{G}_i' > 0$, and $\bar{L}_i' > 0$. Since $\delta_w^{j\prime\prime} < 0$ and $\delta_l^{j\prime\prime} > 0$ then the second bracketed term is negative. Now, $(\partial \bar{G}_i' / \partial a) = (1/M)$ and $(\partial \bar{L}_i' / \partial a) = 1/N$. Thus, the first bracketed term is negative, zero, or positive if and only if,

$$\frac{W_j\delta_w^{j\prime}}{N_j\delta_l^{j\prime}} \lesseqgtr \frac{W}{N}.$$

From the first order condition,

$$\frac{W_j\delta_w^{j\prime}}{N_j\delta_l^{j\prime}} = \left[\frac{W}{N}\right]\left[\frac{\bar{L}_j'}{\bar{G}_i'}\right] = \left[\frac{W}{N}\right]\left[\frac{(\hat{p}_j^i + s)(b - c) + h(\hat{p}_j^i)}{h(\hat{p}_j^i)}\right].$$

Hence, if $(b - c) \leq 0$,

$$\frac{W_j \delta_w^{j'}}{N_j \delta_l^{j'}} = \frac{\bar{L}_i'}{\bar{G}_i'} < \frac{W}{N} .$$

By continuity, there is some $\gamma > 0$ such that, for any $b \in (c, c + \gamma)$, the second bracketed term is greater in absolute value than the first bracketed term. □

The condition in proposition 4.5—that supply not be too elastic—seems counterintuitive. But, in fact, it makes sense. Consider Figure 4.5a. The increased gain to producers due to technological innovation is given by $(A + B + C)$ while the added loss to consumers is given by $[(A + B) + (D + E)]$.[12] Now if the supply were much more elastic, as shown in Figure 4.5b, the increased gain to producers would be smaller—$(A' + B' + C') < (A + B + C)$ and, likewise, the added loss to consumers would be smaller—$(A' + B') < (A + B)$ and $(D' + E') = (D + E)$. Hence, at the margin, the legislator could increase his net gain in votes by raising the support level slightly.

E.3 Input Restrictions:

One way of reducing the surplus under a price floor is by imposing restrictions on inputs, e.g., a limit on the acreage a farmer can plant to a supported crop. Graphically, input restrictions can be represented by a tilting of the supply curve upward and, analytically, by a fall in the value of b. Proposition 4.6 indicates that a legislator will want to raise the support level if input restrictions are imposed.

PROPOSITION 4.6:

Let i be a price floor. Then there exists a $\gamma' > 0$ such that, for all $b \in (0, c + \gamma')$, $(\partial \hat{p}_j^i / \partial b) < 0$.

Proof:

It can easily be shown that,

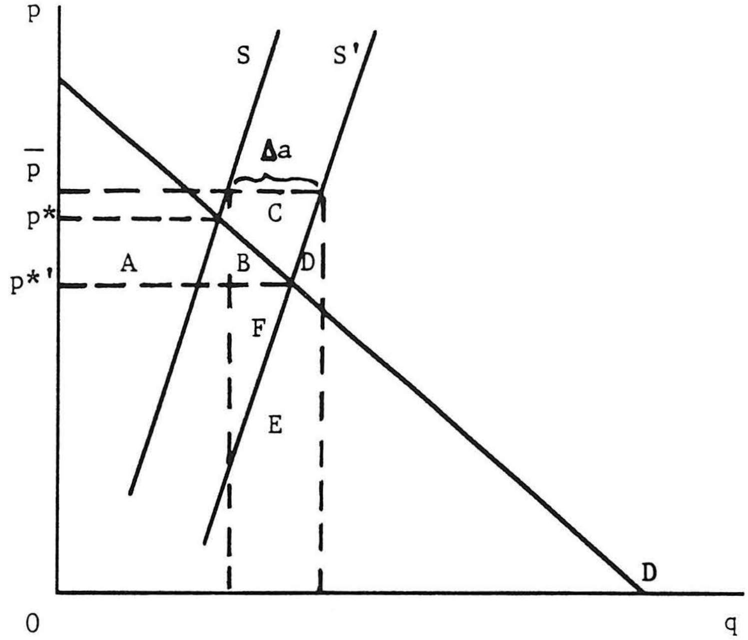


FIGURE 4.5 a

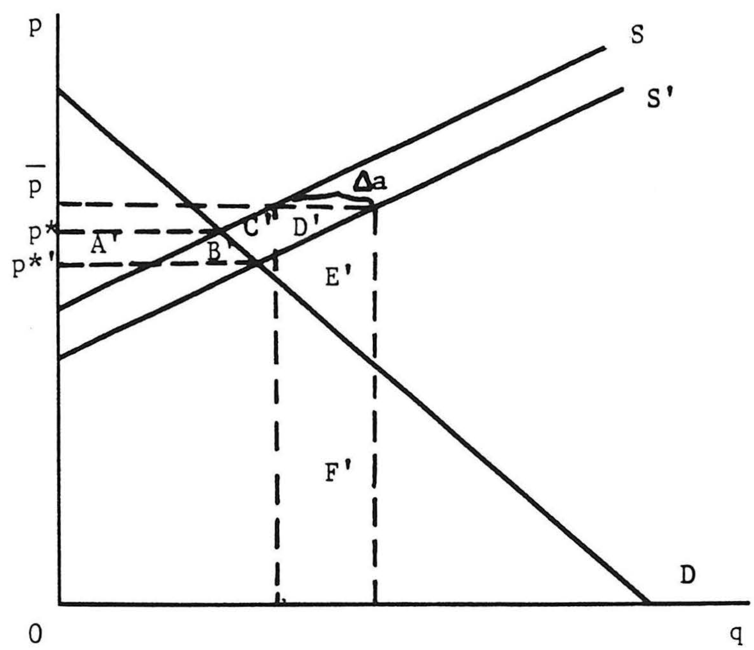


FIGURE 4.5 b

$$\frac{\partial Q'_{j,i}}{\partial b} = \left[W_j \delta'_w \frac{\partial \bar{G}'_i}{\partial b} - N_j \delta'_l \frac{\partial \bar{L}'_i}{\partial b} \right] + \left[W_j \delta''_w \frac{\partial \bar{G}_i}{\partial b} \bar{G}'_i - N_j \delta''_l \frac{\partial \bar{L}_i}{\partial b} \bar{L}'_i \right] .$$

The second bracketed term on the right-hand side is negative. The first bracketed term is negative if and only if

$$\frac{W_j \delta'_w}{N_j \delta'_l} < \left[\frac{W}{N} \right] \left[\frac{\partial L'_i / \partial b}{\partial G'_i / \partial b} \right] = \left[\frac{W}{N} \right] (2 + \frac{s}{\hat{p}^i_j}) .$$

From the first order condition, if $(b - c) \leq 0$ then,

$$\frac{W_j \delta'_w}{N_j \delta'_l} < \left[\frac{W}{N} \right] .$$

This means

$$\left[\frac{W}{N} \right] < \left[\frac{W}{N} \right] \left[\frac{\partial L'_i / \partial b}{\partial G'_i / \partial b} \right] .$$

Hence, $(\partial \hat{p}^i_j / \partial b) < 0$ if $(b - c) \leq 0$. The conclusion follows from the continuity of G_i and L_i in b. □

E.4 <u>A Change in the Surplus</u>:

Propositions 4.5 and 4.6 deal only with changes in the surplus at the margin. But the magnitude of the surplus also affects the choice of the legislator. As formalized in proposition 4.7, the greater the magnitude, the lower the legislator's desired price support level.

PROPOSITION 4.7:

Let i be a price floor and $S(\bar{p}) = (h(\bar{p}) - f(\bar{p}))$. Then, $(\partial \hat{p}^i_j / \partial S) < 0$.

Proof:

Note that

$$\frac{\partial Q'_{j,i}}{\partial S} = - N_j \delta''_l \frac{\partial \bar{L}'_i}{\partial S} \bar{L}'_i .$$

Now, by definition, $L_i(\bar{p}) = \int_{p^*}^{\bar{p}} f(p)dp + S(\bar{p})$. Hence, $(\partial L_i / \partial S) = 1$. Consequently,

$(\partial Q'_{j,i} / \partial S) < 0$. □

E.5 The Response of Legislators from 'NonProducer' Districts:

So far, I have been implicitly assuming that the optimal choice of a legislator is an interior point—$p_j^i \in (p^*, p_m)$. In other words, I have been discussing the response of legislators representing districts with a *relatively* large number of producers. Analogous conclusions hold for those legislators representing districts with relatively few producers—$\hat{p}_j^i = p^*$; that is, those who represent nonproducer districts. Technological change, input restrictions, and, in general, any change in the surplus affect these legislators' resistance at the bargaining table. A build-up in the surplus tends to increase their opposition to price supports. A rise in the surplus increases the tax burden. This shifts the objective functions of the legislators downward at each possible nondegenerate price support level. I illustrate this in Figure 4.6.

What this means is that a representative of a nonproducer district will tend to bargain harder for lower support levels. The same conclusion holds if the ratio of producers to consumers falls; a fall in (W_j/N_j) either due to a decline in the number of producers in the district or a rise in the number of consumers makes the representative more hard-nosed. I summarize these results in the following proposition.

PROPOSITION 4.8:

A rise in the surplus or a fall in (W_j/N_j) in non-producer districts results in a fall in the price support level.

By assumption, majority of the members in the k^{th} subcommittee desire an effective price support—$\hat{p}_j^i \in (p^*, p_m)$; they represent producer districts. Hence, the desired support level of the subcommittee, the median legislator's optimal choice, would be nondegenerate. Since the whole body's desired level is a weighted average of the free market price for commodity k and

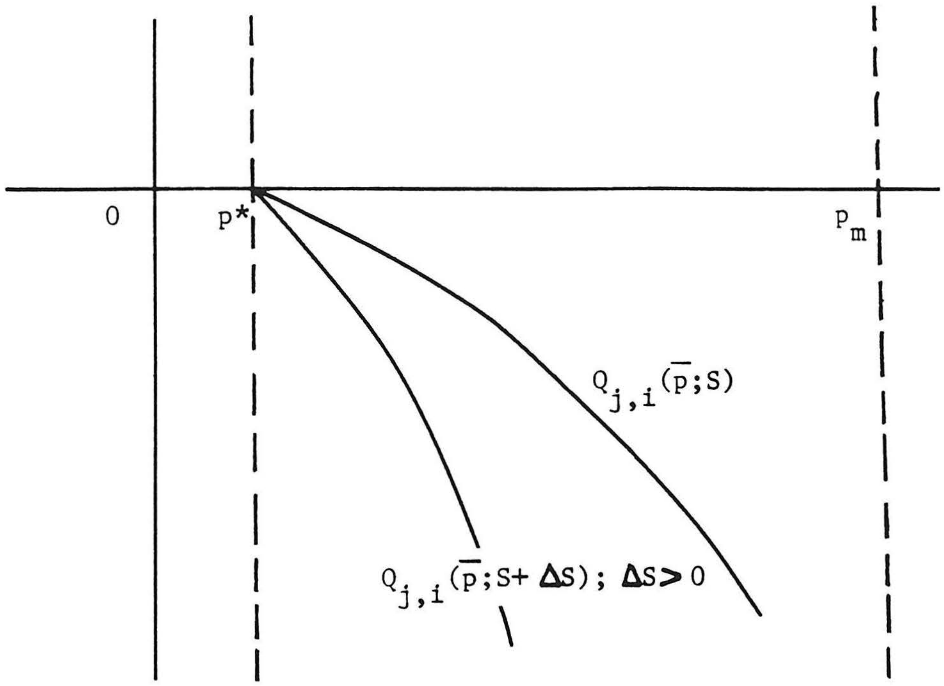


FIGURE 4.6

the subcommittee's desired level—$[(1-\mu)p^{k*} + \mu\tilde{p}^{\,i(k)}]$—then Propositions 4.4 through 4.8 imply that the body's desired level will change in response to changes in the selected parameters. Both $\tilde{p}^{\,i(k)}$ and μ change (in the same direction) as these parameters shift.

One can derive predictions with respect to other instruments. However, I will not do this. Instead, I will test the above stated predictions against the actual behavior of price supports (in the U.S.) for the feed grains.

F. An Econometric Analysis of Comparative Statics Predictions:

Since price supports have been a fundamental element of agricultural legislation in the U.S. since the thirties, agriculture provides a suitable domain for investigation. From 1930 to 1939, and 1952 to 1963, the major agricultural commodities were supported via a price floor, combined with varying degrees of acreage controls (input restrictions). But beginning in 1965, the price floor was abandoned as the basic method of support; hence, I will omit this period from my analysis. I will also exclude the period 1930 to 1939, since institutions and surrounding circumstances then were different.[13]

Before I proceed, I should point out that the U.S. Congress satisfies the institutional and behavioral properties of my model. First, Congress is divided into committees. Second, price support legislation is assigned to a single committee, the Agricultural Committee. Third, the agricultural committee is divided into subcommittees, with each subcommittee basically responsible for price support legislation pertaining to a single supported commodity. Fourth, legislators in a given subcommittee come mostly from districts producing the commodity for which the subcommittee is responsible. And, fifth, the Agricultural Committee in each chamber has some bargaining power vis-a-vis noncommittee members.

Since there are only twelve years within the period of study (1952-1963), it is not advisable to do statistical work on each individual commodity. Twelve observations contain very little information. To circumvent this problem, I will concentrate on the feed grains markets. Feed grains consist basically of four commodities, namely corn, grain sorghum, barley, and oats. Being feed grains, they have some properties in common and thus can be logically lumped into a single econometric model to generate (significantly) more observations.[14]

The data used in the analysis comes from the U.S Department of Agriculture, "Feed: Outlook and Statistical Yearbook, 1985"[15]. It was crosschecked with data from Cochrane and Ryan's classic study (1976) of U.S. agricultural policy, "American Farm Policy, 1948-1973."

The predictions of the political model (again under a price floor) can be rephrased in the form of hypotheses, which in turn can be tested statistically using the above data.

H1: If the number of rural Congressional districts declines relative to the number of metropolitan districts, then the price support levels will also decline.

The next hypotheses follow correspondingly from Propositions 4.5, 4.6, and 4.7, each in conjunction with Proposition 4.8.

H2: The adoption of new technology, as measured by rising yields per acre, leads to a fall in price support levels.[16]

H3: The imposition of acreage controls results in higher price support levels. Acreage controls are a form of input restrictions and thus lead to an increase in the slope of the supply curve (under competitive conditions), which in turn leads to a fall in the potential surplus and ultimately to higher price supports.

H4: The larger the surplus of a commodity in a given period, the lower its price support the next period.

There is one more hypothesis that can be tested but which does not stem (at least directly) from the political model. Since the U.S. Department of Agriculture (USDA) plays a major role in agricultural legislation and since it represents the viewpoint of the President on agricultural policy, then the President has some bearing on the outcome of price support legislation.

H5: The President has a nontrivial influence on price supports. Furthermore, a Republican President exerts a downward pressure on price supports as opposed to a Democratic President. In general, Republicans favor the free market, while Democrats favor some form of government intervention. Many Democrats believe the market does not function as well as hoped for.

In order to test these hypotheses, I will specify the following linear regression model,

$$ps_{it} = \alpha_0 + \sum_{j=1}^{4} \alpha_j d_j y_{it} + \sum_{j=1}^{4} \gamma_j d_j S_{i(t-1)} + \sum_{j=1}^{4} \delta_j d_j a_{it} + \beta_1 P_{(t-1)} + \beta_2 r_{(t-1)} + \varepsilon_{it} \tag{4.4}$$

where

$ps_{it} =$ price support of commodity i at time t

$y_{it} =$ yield per acre of commodity i at time t

$S_{i(t-1)} =$ surplus of commodity i at time $(t-1)$

$a_{it} =$ acreage diverted from production of i at time t

$P_{(t-1)} =$ a dummy which takes on the value 1 if the President is Republican and 0 if he is a Democrat.

$r_{(t-1)} =$ the ratio of rural and predominantly rural to urban and predominantly urban Congressional districts at $(t-1)$.

Notice that the time indices differ across the exogeneous variables: t for per acre yields and acreage controls and $(t-1)$ for the rest. The reason for this is as follows. Decisions on price supports at time t are made at time $(t-1)$ largely on the basis of the existing surplus, $S_{i(t-1)}$. However, since it is not known at $(t-1)$ how much yields per acre will be at t and how much land will be withdrawn at t, Congress grants the Secretary of Agriculture the authority to adjust price support levels at time t within limits specified at $(t-1)$. Thus, the index t is appropriate for yields and acreage controls. Indexing the presidency and the ratio of rural to urban Congressional districts with t is, of course, self-explanatory.

As mentioned earlier, I will restrict the analysis to the feed grains—(1) corn, (2) grain sorghum, (3) barley, and (4) oats. To simplify matters and consequently generate more degrees of freedom, I will assume γ_j is the same for all j $(j = 1, \ldots, 4)$; that is, a change in the surplus of any feed grain has the same effect on its price support—for all i $(\partial ps_{it}/\partial S_{i(t-1)}) = \gamma$. This is reasonable in light of the fact that the USDA lumps these four commodities under feed grains when evaluating the cost (to the economy) of the various farm programs.[18] With this assumption, the model simplifies to,

$$ps_{it} = \alpha_0 + \sum_{j=1}^{4} \alpha_j d_j y_{it} + \gamma S_{i(t-1)} + \sum_{j=1}^{4} \delta_j d_j a_{it} + \beta_1 P_{(t-1)} + \beta_2 r_{(t-1)} + \varepsilon_{it}{}^{19}. \tag{4.5}$$

Note that the parameters α_0, γ, β_1, and β_2 represent the common structure of the feed grains.

Yield per acre is highly correlated with acreage withdrawn from production. There are two reasons for this. First, farmers tend to use better fertilizer, better seeds, etc., to compensate for the reduction in acreage. Second, they tend to withdraw the relatively less productive acres. This suggests that the acreage control variable a_{it} should be excluded from (4.5). Doing this, however, would result in a correlation between y_{it} and the new error term $\varepsilon_{it}' = a_{it} + \varepsilon_{it}$, i.e., an omission of variables problem.[20] This then requires instrumental variable estimation (or 2SLS) in place of OLS.

An instrumental variable for y_{it} must be uncorrelated with ε_{it}' but highly correlated with y_{it}. Time t is one such variable. Table 4.1 shows the coefficients and their corresponding t-statistics of a simple linear regression of y_{it} on a constant and time t for each of the four feed grains.

TABLE 4.1

	(1) Corn	(2) Grain Sorghum	(3) Barley	(4) Oats
Constant	29.9	13.75	23.33	30.67
	(21.46)	(7.02)	(23.26)	(24.93)
t	2.61	2.05	.95	1.04
	(23.63)	(13.73)	(12.48)	(11.15)
R	.96	.90	.88	.85

The estimates of y_{it} from these regressions are substituted into (4.5), and the resultant equation is then estimated using OLS.

One last comment is in order. Since the ratio of rural to metropolitan congressional districts remained relatively unchanged during the years 1951 to 1962, the term $r_{(t-1)}$ can be absorbed into the constant term. The model to be estimated via OLS thus reduces to,

$$ps_{it} = \alpha_0 + \sum_{j=1}^{4} \alpha_j d_j y_{it}^* + \gamma S_{i(t-1)} + \beta P_{(t-1)} + \varepsilon_{it}' \tag{4.6}$$

where y_{it}^* is the OLS estimate of y_{it} from Table 4.1. Note now that, with (4.6), only hypotheses H2, H4,and H5 will be tested.

The OLS estimates for coefficients in (4.6) are given in Table 4.2; the t statistics are shown in parentheses below the corresponding estimates. The two regressions, *Reg* 1 and *Reg* 2, differ only in that two observations were excluded from the latter.[21] The first exclusion represents data for grain sorghum in 1952; in 1951 there was practically no surplus of sorghum, so that the 1952 price support program was basically inoperative (recall that decisions at t were based largely on the surplus at $(t-1)$). The second represents data for corn in 1960; in 1960, the surplus of corn was inordinately high due to the abandonment of the Soil Bank program—an acreage restriction program aimed principally at controlling corn production—in 1959.

TABLE 4.2

	Reg 1	*Reg* 2
Constant	1.842	1.893
	(18.13)**	(19.66)**
Yield per acre, Corn	-.008	-.008
	(-3.34)**	(-3.60)**
Yield per acre, Sorghum	-.017	-.016
	(-2.80)**	(-2.81)**
Yield per acre, Barley	-.025	-.026
	(-6.51)**	(-7.36)**
Yield per acre, Oats	-.029	-.03
	(-10.46)**	(-11.72)**
Surplus at $(t-1)$	-.0001	-.0002
	(-1.35)	(-2.27)*
Presidency at $(t-1)$	-.068	-.073
	(-1.98)*	(-2.36)**
R^2	.878	.91

**: significant at the 1 percent level
*: significant at the 5 percent level

As expected, the coefficients of the exogeneous variables have the correct signs. Under the second regression, H2 and H5 are "accepted" at the one percent level while H4 is "accepted" at the five percent level. The estimated equation for corn price supports is,

$$ps_{it} = 1.893 - .008y_{it} - .0002S_{i(t-1)} - .073P_{(t-1)},$$

for grain sorghum,

$$ps_{2t} = 1.893 - .016y_{2t} - .0002s_{i(t-1)} - .073P_{(t-1)},$$

for barley,

$$ps_{3t} = 1.893 - .025y_{3t} - .0002S_{i(t-1)} - .073P_{(t-1)},$$

and for oats,

$$ps_{4t} = 1.893 - .03y_{4t} - .0002S_{i(t-1)} - .073P_{(t-1)}.$$

FOOTNOTES

1. Some producers may dislike intervention or may like the legislator for his support of other issues.

2. The simplest case is when $f^j = 1$ and $h^j = 0$.

3. Recall that for a Bernoulli random variable X with parameter p, $E(X) = p$. Thus, expected votes from producers is $W_j E(X_w) = W_j \delta_w^j((\bar{G}(\bar{p}))$ and from consumers $N_j E(X_l) = N_j \delta_l^j(\bar{L}(\bar{p}))$.

4. More precisely, I assume $Q_j'' < 0$ which is a bit stronger.

5. Note that strict concavity implies that the right derivative at p^* is non-positive, i.e., $\lim_{\bar{p} \to p^*} Q_j'(\bar{p}) \leq 0$.

6. A surjection is an onto correspondence.

7. This, of course, implies there are enough such legislators. This is reasonable since price supports are assumed to be a major piece of legislation.

8. I assume for simplicity that $|C|$ is odd.

9. The gain and loss functions depend on the instrument adopted (I will expound on this further in the next chapter). It could very well be the case that δ_w^j and δ_l^j also depend on the instrument.

10. Equivalently, $(\partial \hat{p}_j^i / \partial M_j) > 0$: a fall in the number of producers in his district relative to the number of consumers induces the legislator to favor a lower support level.

11. An effective price floor necessarily results in a surplus of $(h(\bar{p}) - f(\bar{p}))$.

12. In fact, consumers may even underestimate $(A + B)$ and $(A' + B')$. Since the price they pay remains the same, then consumers can only observe directly the loss due to the rise in the surplus, i.e., $(D + E)$. That is, consumers underestimate their loss.

13. I can include this period in the econometric analysis by adding a dummy variable. I have decided not to do this for reasons stated in the text.

14. Since other commodities, such as wheat or cotton, are distinctively dissimilar from feed grains, lumping all commodities within one big econometric model would be equivalent to analyzing each commodity individually.

15. I am grateful to David Hull of the USDA Feedgrains Section for his assistance on this matter.

16. Yield per acre may rise as a result of, either changing relative prices between land and other inputs (notably capital and labor), or technological innovation. Thus, to test this hypothesis, one must ascertain that technological innovation had a relatively greater impact on per acre yields during the period being analyzed. Cochrane (1978, p.328) does in fact

attest to this:

"The technological payoff began in 1937 and continued for nearly thirty years. Output per unit of input increased irregularly but persistently from 1937 to 1965, as farmers adopted one new and improved technology after another. This is the way that total farm output increased over the long period, 1937-65. Over this period the input of productive resources held almost constant. In fact, the loss of human labor inputs was almost exactly balanced by the addition of capital inputs. Farmers increased their total output year after year by adopting new and more productive technologies, embodied in capital, year after year."

17. Farmers are paid to reduce their acreage and thus are compensated for the increased production costs that come with acreage restrictions, and in part for the potential loss in producer surplus. Hence, at the margin, their gains are reduced only slightly while the losses of consumers quite significantly; this results in less political resistance to higher price supports.

18. The cost of supporting wheat, as well as cotton and other major commodities, is considered separately under wheat program costs, but the cost of supporting corn, sorghum, barley, and oats are aggregated under feed grains program costs.

19. I assume the error terms are identically, independently, and normally distributed:

$$\varepsilon_{it} \sim N(0,\sigma_i^2) \text{ and } cov(\varepsilon_{it}, \varepsilon_{js}) = \begin{cases} \sigma_i^2, j = 1 \text{ and } s = t \\ 0, \text{ otherwise .} \end{cases}$$

20. I am, of course, assuming that (4.3) is the true model.

21. Each was rejected under a studentized t-test for residuals at the 1 percent level.

PART II

SOME NONTRADITIONAL ECONOMIC MODELS

CHAPTER 5

THE ECONOMIC THEORY OF REGULATION AND THE CHOICE OF INSTRUMENTS

As discussed earlier, political models are incapable of addressing the problem of instrument choice: why is one method chosen over others in implementing a regulatory policy? They cannot tell us much about the nature of regulation. They can only explain, though inadequately, why regulation might result in inefficiency.

Some economists have approached the problem of rationalizing government intervention (in markets) that creates rather than rectifies inefficiencies in a nontraditional way. They treat regulation, i.e. government intervention, as the outcome of competition among interest groups. Foremost among them are Stigler, Peltzman, and Becker.

The Stigler/Peltzman and Becker models are institution-deficient, particularly the latter. Each assumes a black box that encompasses all relevant institutions and which transforms in some unknown way interest group pressures into outcomes. Hence, like the political models, neither provides a clear mapping from political and economic considerations onto policy outcomes.

Unlike the political models, however, these models address, or at least can be adapted to address, the instrument choice problem. Unfortunately, the models either assume that the method of implementation is unimportant (Stigler and Peltzman) or that political institutions do not affect the choice of method (Becker). Thus, the Stigler/Peltzman model completely ignores the problem while Becker model addresses it in a way that many find unacceptable—in particular, political scientists.

In this chapter, I will summarize both the Stigler/Peltzman and the Becker models and will point out their weaknesses with regard to the instrument choice problem. In chapter six, I will then expand the Stigler/Peltzman model in a way that makes it suitable for addressing the problem.

A. The Stigler/Peltzman Model:

Economists' interest in the existence of inefficient regulatory outcomes resulted in an economic theory of regulation. Stigler motivated the theory. Peltzman formalized it. And in some sense Becker generalized it. Stigler effectively developed a theory of the optimal coalition size. He treats regulation as an instrument for wealth transfer and assumes that any form of regulation is equivalent to a tax on wealth. He concludes that diminishing marginal political returns to legislators and increasing marginal organizational costs to interest groups limit the size of the winning coalition, and that the benefits of a uniform tax, such as an effective price support, can be identified with a single economic interest. His argument boils down to the following: first, a regulatory policy must necessarily split a legislator's constituency into a winning group and a losing group; second, the tax rate chosen depends on factors that affect benefits to the winning group and losses to the losing group. These are crucial factors that the political models fail to account for.

Stigler concludes further that regulation yields a more efficient allocation of resources than a pure monopoly but not necessarily an optimum. In this sense, he provides an explanation for the existence of socially nonbeneficial regulation.

Peltzman constructed a formal model of Stigler's theory. He uses supply-demand analysis to derive Stigler's conclusion. Regulatory outcomes result from the interaction of the demand for and the supply of regulation. The demand for regulation stems from constituents,and the supply is provided solely by a legislator. Demand is inversely related to regulation: as the effective tax increases, the wealth of the taxed group falls.[1] This increases opposition and thus raises the cost of regulation to the legislator and ultimately to the group formed by regulation. This then reduces the "quantity" of regulation desired. In short, a legislator is a monopoly supplier faced with a downward-sloping demand curve.

More formally, a legislator has the following objective function,

$M = n \cdot f - (N - n) \cdot h$, where

M = expected votes

n = total number of potential voters in the beneficiary group

f = net probability that a beneficiary will vote for the legislator

N = total number of voters

h = net probability that a victim will vote against the legislator .

The probability factor f depends on the net gain of regulation g to a beneficiary. More precisely,

$f = f(g)$, $g = (T - K - C(n))/n$ where

T= total wealth transferred the beneficiary group

K= total amount spent by beneficiaries mitigate opposition (e.g., campaign funds, lobbying)

$C(n)$ = organizational costs

It is assumed that $f' > 0$, $f'' < 0$, and $C' > 0$. The probability function h depends on the tax rate, t, and on the expenditures per victim undertaken by beneficiaries to mitigate opposition, z. That is, $h = h(t, z)$ with $z = K/(N - n)$; it is assumed that $h_z < 0$, $h_{zz} > 0$, $h_t > 0$, and $h_{tt} > 0$. Finally, note that, given an individual's wealth function, $B(t)$, it must be the case that $(B(t)t(N - n) - T) = 0$. As indicated earlier $B' < 0$; B'' is assumed to be nonpositive.

The optimal solution to the legislator's problem must satisfy the following conditions:

$$\frac{\partial M}{\partial n} = \left[nf' \frac{\partial g}{\partial n} + f \right] - \left[(N - n)\{h_t \frac{\partial t}{\partial n} + h_z \frac{\partial z}{\partial n}\} + h \right] = 0 , \tag{5.1}$$

$$\frac{\partial M}{\partial T} = nf' \frac{\partial g}{\partial T} - (N - n)h_t \frac{\partial t}{\partial T} = 0 , \text{ and} \tag{5.2}$$

$$\frac{\partial M}{\partial K} = - f' - h_z = 0 . \tag{5.3}$$

Given the above identity—$(B(t)t(N - n) - T) = 0$—it follows that,

$$\frac{\partial t}{\partial n} = \frac{tB}{(tB' + B)(N - n)} \text{ and } \frac{\partial t}{\partial T} = \frac{1}{(tB' + B)(N - n)} . \tag{5.4}$$

Substituting these expressions into (5.1) and (5.2) and rearranging results in

$$-[C' + g]f' + f - h_t\left[\frac{tB}{(tB' + B)}\right] - h_z z = 0 \text{, and} \tag{5.1'}$$

$$f' - h_t\left[\frac{1}{(tB' + B)}\right] = 0 . \tag{5.2'}$$

Using (5.1′), (5.2′), (5.3) and the definitions of g, t, and z, the following expression implicitly defining the optimal n can be derived:[2]

$$\frac{n}{N} = 1 - \left[\frac{f'(g + a)}{f + h - f'(c' - a)}\right] \text{ where } a = (C(n)/n) . \tag{5.4}$$

Equation (5.4) can be used to derive Stigler's first conclusion. First note that $0 \le (n/N) \le 1$ so that $0 \le \left[\frac{(g + a)f'}{f + h - f'(c' - a)}\right] \le 1$. Suppose $c' = a = 0$, i.e., zero organizational costs then $(n/N) = (gf')/(f + n)$. Since f is increasing but strictly concave, then $f' < (f/g)$.[3] This means $0 < [(gf')/(f + n)] < 1$—even if there are no organizational costs, $(n/N) < 1$. Note that this follows from diminishing political returns ($f' > 0, f'' < 0$). If instead $c', a > 0$, then the optimal proportion falls even further since

$$\frac{gf'}{(f + h)} < \frac{gf' + af'}{(f + h) + af'} < \frac{(g + a)f'}{(f + h) + af' - c'f'} = \frac{(g + a)f'}{(f + h) - (c' - a)f'} .$$

In sum, due to diminishing marginal political returns and rising marginal organizational costs, the proportion of the total population benefiting from regulation will always be less than one.

From (5.2′), $(h_t/f') = (tB' + B)$. Let $R_t = (h_t/f')$ and $W_t = (B + tB')$, then $(dR_t/dt) = [(f'h_{tt} - h_t f'')/(f')^2]$, which is positive, and $(dW_t/dt) + (2B' + tB'')$, which is negative. Thus, R_t is upward-sloping and W_t is downward- sloping. The optimal tax rate, t^*, is determined by the intersection of these two curves as shown in Figure 5.1. Now the wealth transfer will be maximized only if $(\partial T/\partial t) = 0$ which implies $W_t = 0$. This occurs at t_m which is the tax rate a monopolist would choose if left unregulated.[4] Thus, the allocation of resources would be non-optimal ($t^* > 0$) but not as inefficient as under a monopoly ($t^* < t_m$). This verifies

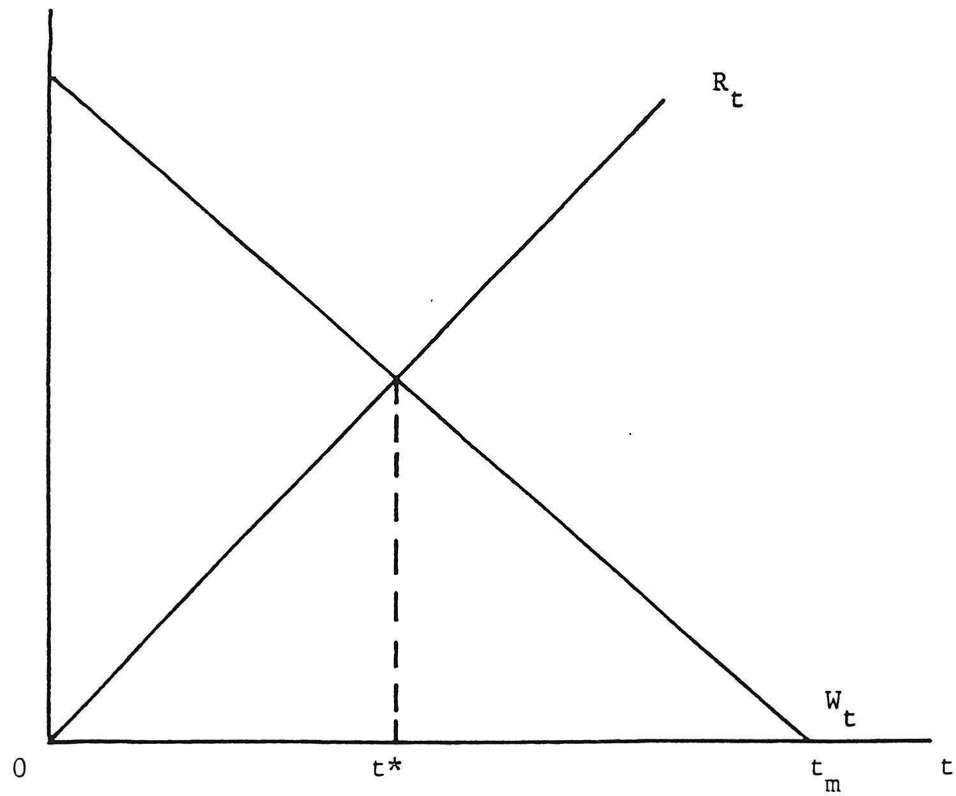


FIGURE 5.1

Stigler's other conclusion.

Unlike the political models, the Stigler model recognizes that the preferences of a legislator are induced by external factors, in particular economic conditions.[5] Changes in these factors affect the benefits and losses, and via constituents' responses, alter the legislator's preferences. However, the model conveniently disregards congressional institutions and reduces Congress to a single vote-maximizing legislator. This is one shortcoming of the model. As argued earlier, the existence of price support policies depends crucially on Congressional institutions. Without these institutions, vote maximization by legislators would most likely lead to free market prices.

More important, though, is that his model implicitly assumes that the manner in which a regulation is implemented is inconsequential. This fails to squareoff with actual regulation. As I will illustrate later on, the character of a regulation tends to vary across markets and within a given market over time. In particular, the methods by which prices of agricultural commodities have been supported differ considerably both cross-sectionally and temporally. It turns out though that a slight alteration of his model makes it suitable for analyzing the choice among alternative instruments, e.g., different price support programs. I will discuss this in detail in the next chapter.

B. The Becker Model:

Like Stigler, Becker focuses on the competition among interest groups as a way of "unifying the view that governments correct market failures with the view that they favor the politically powerful."[6] But he takes a more general approach. He develops a model that is applicable not only to democratic but also to nondemocratic countries. He circumvents the political structure by introducing an influence function, a function that summarizes the interaction between the structure and pressures from various interest groups within the country.

Although he deals with the case of many interest groups, Becker derives his major conclusions from the special case of two homogeneous groups—one subsidized group called s and one taxed called t. To simplify matters, he defines a tax (subsidy) as any political activity that lowers (raises) the income of a group.

In Becker's model, each member of t is taxed an amount R_t (the same for all members of t) and each member of s is subsidized by an amount R_s. Total taxes raised amount to $n_t F(R_t)$ where n_t is the number of individuals in t and F a function that accounts for the deadweight loss stemming from the tax. F is assumed to satisfy the following properties: $F(R_t) \leq R_t$, $0 < F' < 1$, and $F'' \leq 0$. Total subsidies amount to $n_s G(R_s)$ with n_s and G_s interpreted similarly; G satisfies: $G(R_s) \geq R_s$, $G' \geq 1$, and $G'' \geq 0$. The functions F and G are illustrated in Figures 5.2a - 5.2b below. Taxes and subsidies must always balance out—$n_s G(R_s) - n_t F(R_t) \equiv 0$.

The taxes imposed on t depends on its political influence. That is,

$$n_t F(R_t) = -I^t(p_s, p_t, x) \text{ where } I^t \text{ is its influence function .}$$

Note that I^t depends on pressure exerted by s, p_s, pressure exerted by t, p_t, and other exogenous factors, x. Likewise, the level of subsidy that s can obtain depends on its political influence,

$$n_s G(R_s) = I^s(p_s, p_t, x) .$$

Given the above identity $I^s + I^t \equiv 0$; that is, competition among the two groups is a zero-sum game. It is assumed that $(\partial I^s/\partial p_s)$, $(\partial I^t/\partial p_t) > 0$ (which implies $(\partial I^t/\partial p_s)$, $(\partial I^s/\partial p_t) < 0$).

The level of pressure exerted by t or s depends on its expenditures and its size. This is summed up by pressure functions $p_s = p_s(m_s, n_s)$ and $p_t = p_t(m_t, n_t)$; n_i is the size of group; and m its total expenditures. For simplicity, it is assumed $m_i = a_i n_i$ where a_i is (exogenously determined) per capita expenditure of group i.

Given the specifications above, the subsidized group must solve the following problem,

$$\underset{a_s}{Max}\,(Z_s^0 + R_s - a_s) \text{ subject to } n_s G(R_s) = I^s(p_s, p_t, x) .$$

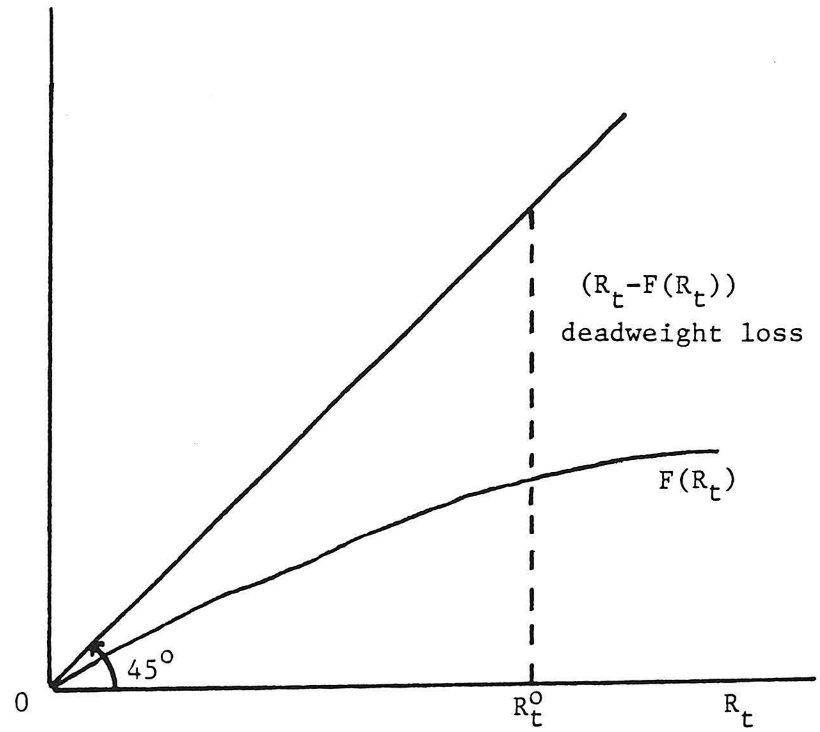


FIGURE 5.2 a

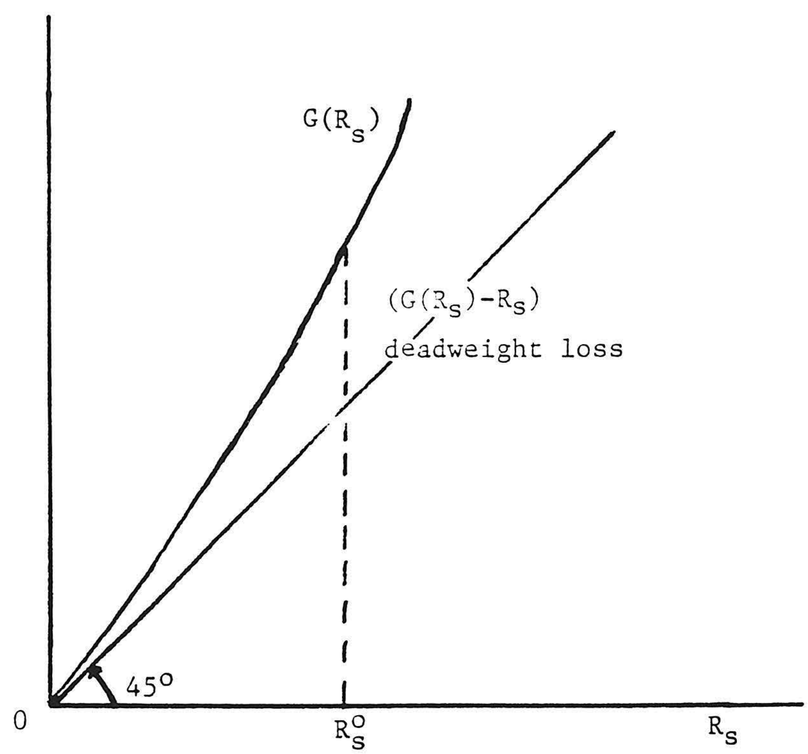


FIGURE 5.2 b

Z_s^0 is the income of a member of s prior to redistribution. Now the constraint implicitly defines R_s as a function of a_s, a_t, n_s, n_t and $x - R_s = R_s(a_s, a_t, n_s, n_t, x)$. Substituting this implicit function into the objective function yields an equivalent maximization problem:

$$\underset{a_s}{Max}(Z_s^0 + R_s(a_s, a_t, n_s, n_t, x) - a_s) \text{ or}$$

$$\underset{a_s}{Max}(R_s(a_s, a_t, n_s, n_t, x) - a_s).$$

Similarly the taxed group is faced with a maximization problem of the form,

$$\underset{a_t}{Max}(Z_t^0 - (R_t(a_s, a_t, n_s, n_t, x) - a_t))$$

or equivalently

$$\underset{a_t}{Min}(R_t(a_s, a_t, n_s, n_t, x) + a_t).$$

Assuming each group takes the other's action (strategy) as given, then the first order conditions to the above problems are,

$$\frac{\partial R_s}{\partial a_s} - 1 = 0 \tag{5.5}$$

$$\frac{\partial R_t}{\partial a_t} + 1 = 0 \tag{5.6}$$

or since $n_s G'(\partial R_s/\partial a_s) = (\partial I^s/\partial p^s) \cdot ((\partial p^s/\partial m_s))n_s$ and $n_t F'(\partial R^t/\partial a_t) = ((\partial I^t/\partial p_t)(\partial p_t/\partial m_t))n_t$,

$$\left[\left[\frac{\partial I^s}{\partial p_s} \cdot \frac{\partial p_s}{\partial m_s}\right]/G'\right] = 1 \tag{5.5'}$$

$$\left[\left[-\frac{\partial I^t}{\partial p_t} \cdot \frac{\partial p_t}{\partial m_t}\right]/F'\right] = -1. \tag{5.6'}$$

Political equilibrium requires that $(\partial I^t/\partial p_t) = -(\partial I^s/\partial p_t)$ so that (5.6′) can be expressed as,

$$\left[\left[\frac{\partial I^s}{\partial p_t} \cdot \frac{\partial p_t}{\partial m_t}\right]/F'\right] = -1. \tag{5.6''}$$

The equations (5.5′) and (5.6″) can then be solved for the optimal per capita expenditures of each group (a_s^*, a_t^*), or equivalently, for the optimal pressure of each, (p_s^*, p_t^*). Becker establishes conditions under which the second order sufficient conditions are satisfied. Note that the solution is a Nash equilibrium.

Becker's derivation of the comparative static results is quite difficult to decipher. Therefore, I will go through the basic steps involved in the mathematics and thereafter will point out how he derives two of his more important propositions.

Let (5.5′) be represented by $\psi(p_s(m_s, n_s)\ p_t(m_t, n_t)) = 0$ and (5.6″) by $\phi(p_s(m_s, n_s), p_t(m_t, n_t)) = 0$. By the implicit function theorem m_i is one-to-one in p_i and n_i, i.e., $m_s = f^{-1}(p_s, n_s)$ and $m_t = h^{-1}(p_t, n_t)$. Thus, ψ and ϕ can be written as $\tilde{\psi}(p_s, p_t, n_s, n_t)$ and $\tilde{\phi}(p_s, p_t, n_s, n_t)$ respectively. Total differentiation with respect to p_s, p_t, and any arbitrary parameter α yields

$$\frac{\partial\tilde{\psi}}{\partial p_s}dp_s + \frac{\partial\tilde{\psi}}{\partial p_t}dp_t + \frac{\partial\tilde{\psi}}{\partial\alpha}d\alpha = 0. \tag{5.7}$$

$$\frac{\partial\tilde{\phi}}{\partial p_s}dp_s + \frac{\partial\tilde{\phi}}{\partial p_t}dp_t + \frac{\partial\tilde{\phi}}{\partial\alpha}d\alpha = 0.$$

Let $(\partial\tilde{\psi}/\partial p_s) \equiv a_{11}$, $(\partial\tilde{\psi}/\partial p_t) \equiv a_{12}$, $(\partial\tilde{\psi}/\partial\alpha) \equiv s_\alpha$, $(\partial\tilde{\phi}/\partial p_s) \equiv a_{21}$, $(\partial\tilde{\phi}/\partial p_t) \equiv a_{22}$, $(\partial\tilde{\phi}/\partial\alpha) \equiv t_\alpha$, and

$$A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}.$$

Then

$$\begin{bmatrix} dp_s \\ dp_t \end{bmatrix} = A^{-1}\begin{bmatrix} -s_\alpha \\ -t_\alpha \end{bmatrix} \alpha_\alpha,$$

or

$$\begin{bmatrix} \dfrac{dp_s}{d\alpha} \\ \dfrac{dp_t}{d\alpha} \end{bmatrix} = \frac{1}{|A|}\begin{bmatrix} a_{22} & -a_{12} \\ -a_{21} & a_{11} \end{bmatrix}\begin{bmatrix} s_\alpha \\ t_\alpha \end{bmatrix}.$$

Given $s_\alpha \neq 0$ but $t_\alpha = 0$, then

$$\frac{dp_s}{d\alpha} = -\frac{a_{22}}{|A|} s_\alpha \text{ and } \frac{dp_t}{d\alpha} = \frac{a_{21}}{|A|} s_\alpha .$$

If $t_\alpha \neq 0$ but $s_\alpha = 0$, then

$$\frac{dp_s}{d\alpha} = \frac{a_{12}}{|A|} t_\alpha \text{ and } \frac{dp_t}{d\alpha} = -\frac{a_{11}}{|A|} t_\alpha .$$

It is tedious though not difficult to show that $a_{11} < 0$, $a_{12} > 0$, $a_{21} < 0$, and $a_{22} > 0$. Thus, provided $|A| < 0$, then

$$sgn(\frac{dp_s}{d\alpha} |_{t_\alpha=0}) = sgn(\frac{-a_{22}}{|A|} s_\alpha) = sgn(s_\alpha) = sgn(\frac{a_{21}}{|A|} s_\alpha) = sgn(\frac{dp_t}{d\alpha} |_{t_\alpha=0})$$

and

$$sgn(\frac{dp_s}{d\alpha} |_{s_\alpha=0}) = sgn(\frac{a_{12}}{|A|} t_\alpha) = -sgn(t_\alpha) = sgn(\frac{-a_{11}}{|A|} t_\alpha) = sgn(\frac{dp_t}{d\alpha} |_{s_\alpha=0}) .$$

Becker derives all his conclusions from these relationships.[7]

Of Becker's propositions, the second and the fourth are the most compelling (at least in my view). The proofs of those propositions are quite straightforward. However, Becker's handling of them was quite unsatisfactory. Hence, I think it is useful to redo them.

Becker's Proposition 2:

An increase in deadweight cost reduces the equilibrium subsidy, i.e., $(\frac{\partial R_s}{\partial G}) > 0$.

Proof:

From (5.5) above, $\frac{dR_s}{dp_s} \cdot \frac{\partial p_s}{\partial m_s} \cdot \frac{\partial m_s}{\partial a_s} = \frac{dR_s}{dp_s} \cdot \frac{\partial p_s}{\partial m_s} n_s = 1$. So, $\frac{dR_s}{dp_s} = \frac{1}{n_s(\partial p_s/\partial m_s)}$ which is positive since $(\partial p_s/\partial m_s) > 0$. Next, it can easily be shown that $(\partial p_s/\partial G > 0$.[8] Hence,

$$\frac{dR_s}{dG} = \frac{dR_s}{dp_s} \cdot \frac{\partial p_s}{\partial G} > 0.$$

This proposition implies that a bias exists in favor of less inefficient (transfer) policies. The next proposition states that relatively more efficient methods of transfer will tend to be adopted.

Becker's Proposition 4:

Competition among pressure groups favors efficient methods of taxation.

Proof:

First, assume (as Becker does) that taxes R_t do not change as the method of taxation changes Let F represent a method of taxation and F^* another but more efficient method, i.e., $F^* > F$ and $F^{*'} > F'$. Suppose a shift is made toward the more efficient method. Then, since $(R_t - F(R_t))$ is deadweight loss, marginal deadweight loss—$(1 - F')$—falls. Now it can be shown that $(\partial p_t / \partial F') < 0$,[9] or equivalently, $(\partial p_t / \partial(1 - F')) > 0$, then since $(1 - F')$ falls, then optimal pressure of group t falls. Since $p_t = p_t(a_t, n_t)$ and $(\partial p_t / \partial \alpha_t)$, then a_t must fall. This implies that per capita expenditure of group t, $(R_t + a_t)$, falls (since R_t is constant). This means the income of each member of group t rises because of the shift to a more efficient method. Thus, members of group t would support such a shift. Next, recall that $n_s G(R_s) = I^s(p_s, p_t, x)$. Hence, $n_s G' \dfrac{\partial R_s}{\partial p_t} = I_t^s$ which implies $(\dfrac{\partial R_s}{\partial p_t}) < 0$. Since $(\dfrac{\partial p_t}{\partial f'} < 0$, then $(\dfrac{\partial R_s}{\partial p_t} \cdot \dfrac{\partial p_t}{\partial F'} > 0$. That is, a shift to a more efficient method raises the equilibrium subsidy.

Hence, both group t and group s would favor and support the shift. □

Becker's model also gives an explanation for the existence of price supports. But it goes one step further than either the political models or the Stigler/Peltzman model. It proposes testable hypotheses about the choice of one regulatory instrument over others. Unfortunately, the model strips away political institutions, much more so than Peltzman's: political institutions are conveniently subsumed in the influence functions $I^s(\cdot)$ and $I^t(\cdot)$. Consequently, its implications are somewhat questionable. For instance, is one to conclude that proposition 4 is valid under both a dictatorship and a democracy or even among different types of democracies? In fact, Bates (1981) provides numerous counterexamples.

Based on the discussion of the political models and nontraditional economic models, there seems to be a need to develop a plausible and tenable model of instrument choice. Neither set of models is well suited for studying the existence of price supports nor for analyzing the choice among alternative price support programs. In the last chapter I developed a model that is better suited to addressing the existence problem. In the next chapter I will expand this model and use it to study the choice between a pure price floor, a price floor with input restrictions, and a production quota. A pure price floor and a production quota are two methods through which the price of a commodity can be supported; they represent opposite extremes—the first does not involve any controls on production and the second a very stringent form of control over production.

FOOTNOTES TO CHAPTER 5

1. An example will clarify this. Consider the simple demand-supply model in Figure 5F.1 without government intervention ($t = 0$), the wealth or tax base is $(p^0 \cdot q^0)$. Now suppose the government decides to impose a 5% tax. What would the tax base be? Offhand, one would think it to be $(p^0 \cdot q^0)$. However, this is incorrect. The 5% tax effectively raises the supply curve to S' so that price and quantity resettle at $(p' \cdot (1.05), q')$. The new tax base would thus be $(p'^{q'})$ which clearly is less than $(p^0 \cdot q^0)$. By a similar argument, it can be shown that a higher tax rate results in a lower wealth base. This process can be succinctly described by a function $B : [0, 1] \rightarrow R^+$ with $B' < 0$.

2. From (5.3) and (5.2′), $h_z = f'$ and $h_t = f'(B + tB')$. Substituting these into (5.1′) yields,

$$-(C' + g)f' + f - f'tB + f'z + h = 0$$

and upon rearranging,

$$(z - (C' + g) - tB)f' + f + h = 0$$

Substituting for g and z,

$$\{(K/(N - n - C' - [(T - K - (C(n)/n)] - [T/(N - n)]\}f' + f + h) = 0$$

or, letting $a = [C(n)/n]$

$$((-C' + a) - (T - K) \cdot (N/h(N - n))f' + f + h = 0 .$$

Further manipulation results in,

$$(N - n/N) = (g + a)f'/(f + h' - (C' - a)f')$$

or

$$(n/N) = 1 - ((g + a)f'/(f + h - (C' - a)f')) .$$

3. To see this, note that for an increasing, strictly concave function, the corresponding marginal curve must be less than the corresponding average curve.

4. Note that $(B + tB')dt = tB$, which is the wealth transfer. Thus t is the tax rate that would yield the largest possible gain to the beneficiary group.

5. For an example, see pp. 222-228 of Peltzman's article, "Toward a More General Theory of Regulation," *Journal of Law and Economics* (1974).

6. "A Theory of Competition Among Pressure Groups for Political Influence," *Quarterly Journal of Economics*, No. 3 (August 1983).

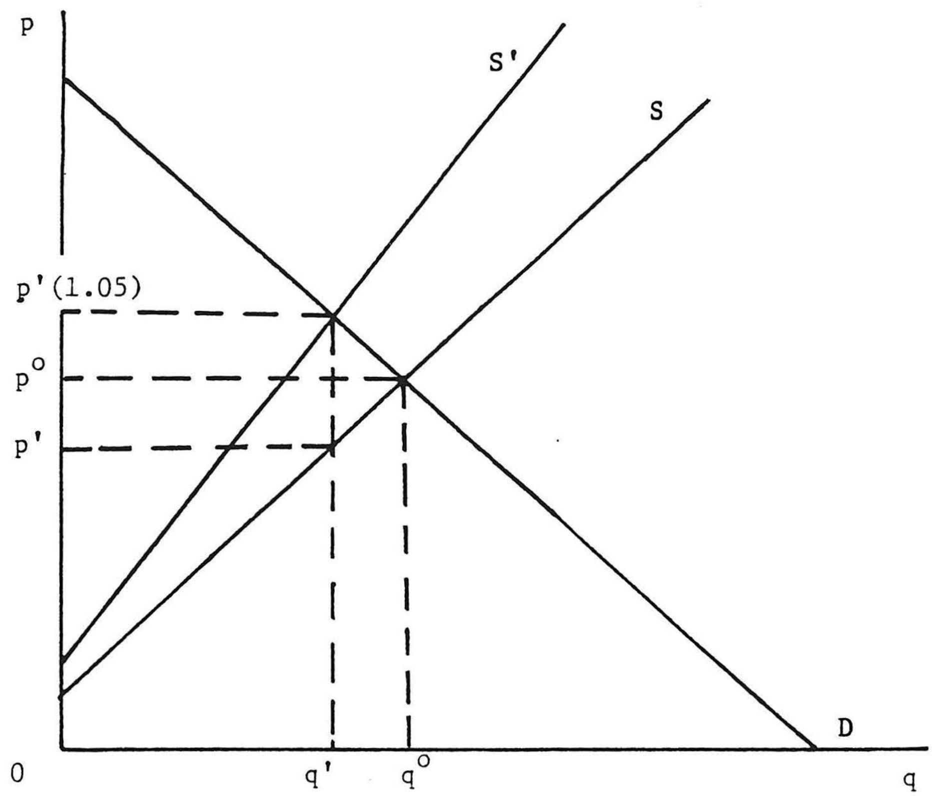


FIGURE 5F.1

7. Surprisingly, in Becker's article, the sign of $|A|$ is claimed to be positive. This has disastrous consequences. If $|A| > 0$ then, from above,

$$sgn(\frac{dp_s}{d\alpha}|_{t_\alpha=0}) = -\,sgn(s_\alpha) = sgn(\frac{dp_t}{d\alpha}|_{t_\alpha=0}) \text{ and}$$

$$sgn(\frac{dp_s}{d\alpha}|_{s_\alpha=0}) = sgn(t_\alpha) = sgn(\frac{dp_t}{d\alpha}|_{t_\alpha=0}).$$

Thus, all of Becker's propositions would have to be reversed. Fortunately, this turns out to be a typographical error, although a crucial one since it tends to throw off the reader. A brief digression will clarify this.
To establish the sign of $|A|$, Becker restructures the optimization problems of each group within a dynamic framework. A group chooses its best strategy at time T given the strategy of the other at time $(T-1)$. That is, the subsidized group solves

$$\underset{a_s^T}{Max}(R_s(a_s^T, a_t^{T-1}, n_s, n_t, x) - a_s^T)$$

and the taxed group,

$$\underset{a_t^T}{Min}(R_t(a_s^{T-1}, a_t^T, n_s, n_t, x) + a_t^T).$$

These lead to a comparative static system which is the dynamic equivalent of (5.7), i.e.,

$$a_{11}dp_s^T + a_{12}dp_t^{T-1} + s_\alpha d\alpha = 0 \qquad (5F.1)$$

$$a_{21}dp_s^{T-1} + a_{22}dp_t^T + t_\alpha d\alpha = 0.$$

Setting $d\alpha = 0$ and solving for dp_s^T leads to,

$$dp_s^T = \left[\frac{a_{12}a_{21}}{a_{11}a_{22}}\right] dp_s^{T-2} \qquad (5F.2)$$

$$dp_s^T - \gamma dp_s^{T-2} = 0 \text{ where } \gamma = \left[\frac{a_{12}a_{21}}{a_{11}a_{22}}\right]. \qquad (5F.2')$$

Equation (5F.2′) is a second order linear homogeneous difference equation with a general solution of the form, $dp_s^T = c_1(\sqrt{\gamma})^T + c_2(-\sqrt{\gamma})^T$ where c_1 and c_2 are arbitrary constants. Hence, for the political equilibrium to be stable (which Becker assumes), γ must be less than 1. Since a_{11}, $a_{21} < 0$ and a_{12}, $a_{22} > 0$ this implies $|A| = a_{11}a_{22} - a_{12}a_{21} < 0$ contrary to what was set forth in the original text.

8. See the Appendix of Becker's article, p. 398—inequality (A.16).

9. See the Appendix of Becker's article, p. 398.

PART III

THE PROBLEM OF INSTRUMENT CHOICE

CHAPTER 6

A MODEL OF INSTRUMENT CHOICE WITH AN APPLICATION TO PRICE SUPPORTS

The economic theory of regulation focuses on rationalizing the existence of regulation. It provides a rational explanation for the existence of inefficient regulatory policies. It views regulation simply as a transfer of wealth from one group in the economy to another. It therefore allows for the possibility of inefficient outcomes.

But the theory is deficient. It implicitly assumes that the method of wealth transfer is inconsequential. However, regulation of markets invariably takes different forms. This is quite evident in the control of imports. The government through the ITC (International Trade Commission) regulates the importation of commodities deemed "injurious" to one or more domestic industries. It may do this directly through tariffs and/or quotas on the imports or indirectly through subsidies for the affected industries. So-called Escape Clause Investigations by the ITC "provide relief in the form of an increase in tariff duties, quantitative restrictions (quotas), or adjustment assistance in loans, tax breaks, and the like."[1] Dumping activities and export subsidization by foreign countries are counteracted by an imposition of a dumping tax and a countervailing duty, respectively.

A variety of methods is also apparent in the regulation of transportation. For instance, railroads are subject to long haul-short haul restrictions, a predetermined fair rate of return on a fair value, intrastate rate controls, and restrictions on abandonment of service while motor carriers ,e.g., trucks, are not. On the other hand, the latter are subject to safety and entry regulations, which generally are not applicable to the former, and to more stringent controls over minimum rates. In general, the different modes are subject to varying degrees of entry, rate, safety, and service regulations. Moreover, even within the same mode, there are some differences. The Motor Carrier Act (enacted in 1935) exempts from regulation the transportation (by motor carrier) of agricultural commodities and newspapers (Sampson and Farris, 1975). Up until 1957, the "Act provided that contract carriers (as opposed to common carriers) file *only* minimum rate schedules with the ICC (Interstate Commerce Commission) and gave the commission authority to control *only* minimum rates."[2] Common carriers had to file *actual* rate schedules; these rates were regulated by the ICC. The Act was eventually amended in 1957.

The regulation of (U.S.) agricultural markets is also a good example. Regulation of agriculture is characterized mainly by price support programs. Different methods are used to support prices of major agricultural commodities. These can be classified roughly into five basic categories: (i) a price floor, (ii) a production quota, (iii) a two-tier price system, (iv) acreage controls, and (v) an income payment scheme. Under a price floor, the government sets a minimum price above the competitive free market level and guarantees producers this price by purchasing and storing any excess production. Under a quota, producers are assigned maximum production limits such that aggregate output is below the free market level. A two-tier price system is generally used for a commodity that is sold in two distinct markets, one of which is characterized by a relatively inelastic demand and the other by a relatively elastic demand. A higher price is set in the former and a lower in the latter. Acreage controls represent a form of input restriction. To avail of price supports, producers must plant within prespecified acreage allotments. Finally, under an income payments scheme, price is allowed to settle at its free market level. The government guarantees producers a minimum price above the free market level by paying them the difference between the minimum price and the free market price. In practice, usually some combination of methods is used. Table 6.1 shows roughly how prices of some major commodities were supported during the period 1952 to 1972 (in Chapter 7, I present a much more detailed classification).

TABLE 6.1

Methods of Support for Selected Commodities, 1952-1972

	(i)	(ii)	(iii)	(iv)	(v)
1952-1964					
Wheat	×			×	
Feed grains	×			×	
Tobacco	×			×	
Dairy			×		
1965-1972					
Wheat				×	×
Feed grains				×	×
Tobacco		×		×	
Dairy			×		

It is quite evident then that the theory and actual regulation diverge. Consequently, the theory is unable to predict the nature of regulation that might arise. Why, for instance, are textiles and tobacco subject to tariffs and not quotas? On the other hand, why is sugar subject to a quota and not a tariff? Why was there a difference in rate controls between contract and common carriers before 1957? Why was there a switch in support methods for wheat, the feed grains, and tobacco in 1965? More generally, why is one form of regulation implemented and not another? This is generally referred to as the problem of instrument choice in regulation.

My objective in this chapter is to provide a building block for a general (positive) theory of choice among regulatory forms. The paper is divided into two parts. In Part I, I construct a political/economic choice model similar to Peltzman's (1976). Like Peltzman, I posit a single legislator as the decision-maker who bases his choice on his expected gain in votes. My model differs from Peltzman's in that the legislator must not only choose a tax rate but also an instrument—that is, a regulatory form—from a fixed set of alternatives. It can be interpreted as a natural extension of Peltzman's model. In Part II, I apply the model to the choice between a price floor and a production quota in the implementation of a price support program. First, I describe the two instruments both graphically and mathematically. Second, I derive sufficient conditions for a quota to prevail over a price floor and vice-versa. Third, I derive some predictions implied by the model. And last, I provide some anecdotal evidence attesting to the consistency of some of the model's predictions with regulation in the wheat and feed grains markets.

My main finding is that the elasticity of demand and the elasticity of supply are crucial factors that affect the choice between the two instruments. Specifically, if demand (supply) is sufficiently inelastic (elastic) at the free market equilibrium, then a quota will be adopted. On the other hand, if demand (supply) is elastic (inelastic), then a price floor will be chosen. Also, I find that an improvement in technology would bias the choice toward a quota, while the implementation of input restrictions would bias the choice toward a price floor. Finally, I conclude that redistricting induces a relaxation of production controls. Technological change was the principal economic factor (Cochrane, 1979), while redistricting was a major political factor (McCubbins and Schwartz, 1986) affecting price support programs during the period 1953 to 1973. Rising yields per acre reflect the improvement in technology.[3] Redistricting refers to a realigning of congressional (voting) districts according to the one man-one vote rule; each district must contain more or less the same number of voters. Prior to 1965, rural areas were overrepresented in Congress since the apportionment of districts then was based on the composition of the population in the 1930s. Redistricting rectified this.

A. A Model of Instrument Choice

One of the basic conclusions of Peltzman (1976) and Stigler (1971) is that a regulatory policy will generally divide people (voters) into two opposing groups: those who benefit from the policy and those who are harmed by it, e.g., farmers vs. consumers in the case of price supports. I will refer to the first as the winning group (or beneficiaries) and the second as the losing group (or losers). Like Peltzman, I assume the decision-maker is a single legislator. In addition, I assume the legislator represents a geographical subunit of the country, e.g., a district.[4] I let j indicate that the legislator comes from the j^{th} district, M_j and N_j the size of the winning group and the size of the losing group within his district respectively, and M and N the total number of beneficiaries and losers in all the districts respectively. Finally, I assume a tax (unit or percentage) is used to generate gains G to the beneficiaries and losses L to the losers; we let gains be defined by a function $G = G(t)$ and losses by a function $L = L(t)$. With these specifications, the legislator's preferences are represented by the following function,

$$Q_j(t) = M_j \delta_w^j(\bar{G}(t)) - N_j \delta_l^j(\bar{L}(t)) \tag{6.1}$$

where

$\delta_w^j \equiv$ the net gain in the probability that a beneficiary in district j will vote for the legislator,

$\delta_l^j \equiv$ the net rise in the probability that a loser in district j will vote against the legislator,

$\bar{G}(t) \equiv (\frac{1}{M})G(t) =$ per capita gain to beneficiaries given a tax rate of t,

$\bar{L}(t) \equiv (\frac{1}{N})L(t) =$ per capita loss to losers given a tax rate of t.

Following Peltzman, we assume that $\delta_w^{j\prime}, \delta_l^{j\prime}, \delta_l^{j\prime\prime} > 0$, $\delta_w^{j\prime\prime} < 0$, and $Q_j^{\prime\prime} < 0$. Also, for convenience, we assume $\delta_w^j(0) = \delta_l^j(0) = 0$. Note that δ_w^j depends on the per capita gain and δ_l^j on the per capita loss. Note also that (6.1) is a generalization of (4.1).

A regulatory policy can be implemented in different ways, called instruments. For any given tax rate, each instrument generally yields a different per capita loss and per capita gain. Let i represent an instrument and $(\bar{G}_i(t), \bar{L}_i(t))$ the per capita gain-loss configuration associated with instrument i at a tax t. Then, the objective (net expected vote) function of legislator j with respect to instrument i is given by

$$Q_{j,}\, i(t) = M_j \delta_w^j(\bar{G}_i(t)) - N_j \delta_l^j(\bar{L}_i(t))\,. \tag{6.2}$$

For simplicity, I assume there is a fixed set of alternative instruments from which the legislator must choose.

The gain and loss functions, G_i and L_i, are determined largely by economic factors such as the levels of demand and supply in the market (being regulated), elasticities, the structure of the market, etc. Hence, the legislator's objective function depends ultimately on political—M_j, N_j, δ_w^j and δ_l^j—and economic variables. His choice therefore depends on the state of these variables.

The legislator's decision process proceeds in two stages. For each instrument, the legislator chooses an optimal tax rate t_j^i to maximize $Q_{j,\,i}$: choose t_j^i such that $Q_{j,\,i}(t_j^i) \geq Q_{j,\,i}(t)$ for all t. He then picks the instrument that yields the largest net gain at the corresponding optimal tax level. Specifically, let μ_i^j represent the vector of parameters (political and economic) associated with instrument i; and define $\Delta_{i,\tilde{i}}$ as follows,

$$\Delta_{i,\tilde{i}} \equiv Q_{j,\,i}(t_j^i(\mu_i^j);\, \mu_i^j) - Q_{j,\tilde{i}}(t_j^{\tilde{i}}(\mu_{\tilde{i}}^j);\, \mu_{\tilde{i}}^j)\,. \tag{6.3}$$

Then the legislator chooses i over $\tilde{i}$ if and only if $\Delta_{i,\tilde{i}} > 0$. The process is illustrated in Figure 6.1 below.

FIGURE 6.1

Stage 1	The legislator chooses the optimal tax rate corresponding to each instrument	t_j^i for all i
		↓
Intervening Stage	The legislator determines the net gain in expected votes under each instrument at its optimal tax rate	$Q_{j,\,i}(t_j^i(\mu_i);\, \mu_i)$ for all i
		↓
Stage 2	The legislator picks the instrument that yields the highest net gain	$Q_{j,\,i^*}(t_j^{i^*}(\mu_{i^*});\, \mu_{i^*})$

As noted earlier, the decision of the legislator depends on both political and economic parameters. Hence, changes in these could lead to a different optimal tax rate for each instrument and consequently to a different choice of instrument. One can analyze the effect of such changes using the technique of comparative statics. That is, let m be any parameter (which may or may not be a scalar element in μ_i). Then $(\partial t_j^i/\partial m)$ would indicate the direction and magnitude of change in the optimal tax rates. Furthermore, if we define $\hat{Q}_{j,\,i}(\mu_i)$ as follows,

$$\hat{Q}_{j,\,i}(\mu_i) \equiv \max_t Q_{j,\,i}(\,\cdot\,;\mu_i)^5 \tag{6.4}$$

then $(\partial\hat{Q}_{j,\,i}/\partial m)$ would give the direction and magnitude of change in the maximum net gain under each instrument.[6] Assuming there are values for the parameters μ_i (for all i) such that the legislator is indifferent among all the instruments, we can then determine how a change in m biases the legislator's choice. For instance, assume there are only two instruments and suppose $\Delta_{1,2} = 0$ initially. Then, a change in m would bias the legislator's choice toward the first if (and only if) $(\partial\Delta_{1,2}/\partial m) > 0$ and toward the second if (and only if) $(\partial\Delta_{1,2}/\partial m) < 0$.

In the next section, I show how the model can be used to analyze the choice of instruments in the implementation of a price support program. To simplify matters, I restrict the analysis to a set of two pure or basic instruments, a price floor and a production quota.

B. AN APPLICATION TO PRICE SUPPORTS

B.1. The Choice Set—A Price Floor and a Production Quota

As mentioned above, I will restrict my attention to two general categories of price support instruments: a price floor above the free market price and a production quota below the free market quantity.

The distinction between a price floor and a production quota can best be explained with supply and demand diagrams. Under the first scheme, the government guarantees producers a price $\bar{p}$ above the free market equilibrium level p^* by offering to purchase their commodity at the price $\bar{p}$ and storing these purchases to keep them from slipping back into the market. The government collects taxes to pay for its purchases and storage of any excess production. The scheme results in an aggregate gain to producers given by,

$$G_1(\bar{p}) = \int_{p^*}^{\bar{p}} h(p)dp$$

where h is the market supply function and an aggregate loss to consumers/taxpayers of,

$$L_1(\bar{p}) = \int_{p^*}^{\bar{p}} f(p)dp + (\bar{p} + s)(h(\bar{p}) - f(\bar{p}))$$

where f is the market demand function and s is the per unit storage cost.[7]

In Figure 6.2a, the gain is represented by the area $(A + B + C)$ and the loss by

$$[(A + B) + (B + C + D + E + F) + s(h(\bar{p}) - f(\bar{p}))] .$$

Under the second scheme, the government legally restricts quantity to $f(\bar{p})$ in order to raise the commodity's price to $\bar{p}$. Here the gain to producers and the loss to consumers are (see Figure 6.2b),

$$G_2(\bar{p}) = (\bar{p} - h^{-1}(f(\bar{p})))f(\bar{p}) - \int_{h^{-1}(f(\bar{p}))}^{p^*} h(p)dp = (A - G)$$

$$L_2(\bar{p}) = \int_{p^*}^{\bar{p}} f(p)dp = (A + B) .$$

To simplify matters, I will focus my analysis on the linear case and leave it up to others to generalize my result. From this point on, I will assume supply and demand are of the form,

$$h(p) = a + bp; b > 0 \text{ and}$$
$$f(p) = d - cp; c > 0, d > 0, (d - a) > 0 .$$

The corresponding free market price is $p^* = [(d - a)/(b + c)]$ and the corresponding gain and loss functions are,

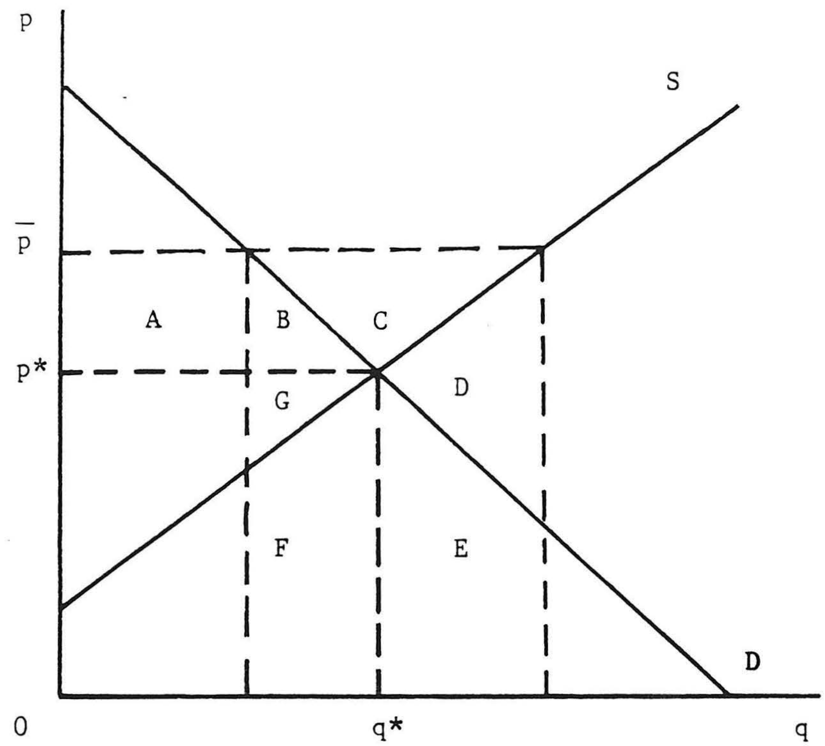


FIGURE 6.2 a

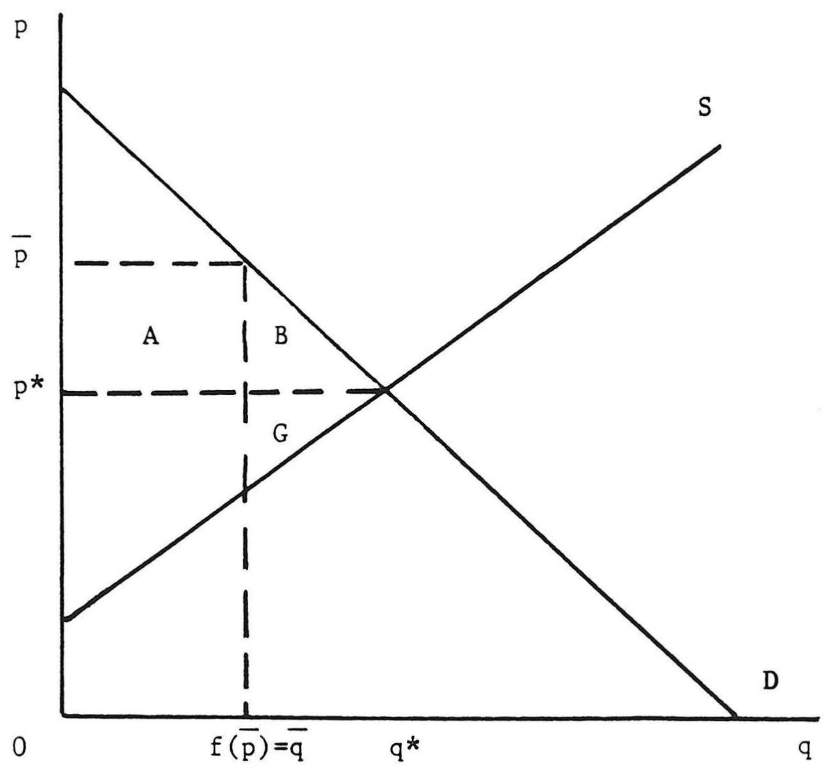


FIGURE 6.2 b

$$G_1(\bar{p}) = (a\bar{p} + \frac{b}{2}\bar{p}^2) - (ap^* + \frac{b}{2}p^{*2})$$

$$L_1(\bar{p}) = (b + \frac{c}{2})\bar{p}^2 + (a + (b + c)s)\bar{p} - (d - a)s - (dp^* - \frac{c}{2}p^{*2})$$

$$G_2(\bar{p}) = -c(1 + \frac{c}{2b})\bar{p}^2 + (\frac{1}{b})[bd + (d - a)c]\bar{p} + [((a - d)^2/(2b)) - (ap^* + \frac{b}{2}p^{*2})]$$

$$L_2(\bar{p}) = (d\bar{p} - \frac{c}{2}\bar{p}^2) - (dp^* - \frac{c}{2}p^{*2}) .$$

Note that the relevant range of prices is $[p^*, p_m]$ where p_m is the maximum price consumers are willing to pay for the commodity, i.e., $f(p_m) = 0$.

B.2. The Legislator's Decision Process

In this example, the beneficiaries are farmers and the losers consumers. For each instrument, the legislator must determine the optimal price support level. In particular, he must choose $\hat{p}_j^1$ and $\hat{p}_j^2$ such that $\hat{p}_j^1$ solves

$$\max_{[p^*, p_m]} Q_{j,1}(\bar{p}) = \max_{[p^*, p_m]} [M_j \delta_w^j(\bar{G}_1(\bar{p})) - N_j \delta_l^j(\bar{L}_1(\bar{p}))] , \tag{6.5}$$

and $\hat{p}_j^2$ solves

$$\max_{[p^*, p_m]} Q_{j,2}(\bar{p}) = \max_{[p^*, p_m]} [M_j \delta_w^j(\bar{G}_2(\bar{p})) - N_j \delta_l^j(\bar{L}_2(\bar{p}))] . \tag{6.6}$$

Then, he must determine which instrument yields the higher net gain in votes. That is, define

$$\Delta_{1,2} \equiv \hat{Q}_{j,1}(\hat{p}_j^1(\mu_1^j); \mu_1^j) - \hat{Q}_{j,2}(\hat{p}_j^2(\mu_2^j); \mu_2^j) \tag{6.7}$$

where once again μ_1^j and μ_2^j are vectors of parameters. Then, he chooses a price floor (1) if and only if $\Delta_{1,2} > 0$ and a production quota (2) if and only if $\Delta_{1,2} < 0$. His decision-making process is depicted in Figure 6.3 below.

FIGURE 6.3

		Price Floor (1)	Production Quota (2)
Stage 1	The legislator chooses the optimal price support level corresponding to each instrument	$\hat{p}_j^1$ ↓	$\hat{p}_j^2$ ↓
Intervening Stage	The legislator determines the net gain in expected votes	$Q_{j,1}(\hat{p}_j^1(\mu_1); \mu_1)$ ↘	↙ $Q_{j,2}(\hat{p}_j^2(\mu_2); \mu_2)$
Stage 2	The legislator picks the instrument that yields the higher net gain	$\Delta_{1,2} > 0$ (pick 1) $\Delta_{1,2} < 0$ (pick 2) $\Delta_{1,2} = 0$ (indifferent)	

The optimal support level corresponding to the i^{th} instrument, $\hat{p}_j^i$, is defined implicitly by the first order condition. That is, $\hat{p}_j^i$ solves

$$Q_{j,i}'(\bar{p}) = M_j \delta_w^j \bar{G}_i'(\bar{p}) - N_j \delta_l^j \bar{L}_i'(\bar{p}) = 0 . \tag{6.8}$$

Since the G_i and L_i depend on a set of parameters μ_i^j then $\hat{p}_j^i$ depends on μ_i^j.[8]

B.3. Comparative Statics and the Choice of Instruments

The choice between instruments 1 and 2 depends in part on the price elasticity of demand at the free market equilibrium. A changing elasticity of demand at the equilibrium can be easily represented mathematically if demand and supply are linear. First fix a at a^0, c at c^0, b at b^0 and d at d^0 so that the free market price p^* is $(d^0 - a^0)/(b^0 + c^0)]$. Then let $d = \bar{d}(c) \equiv p^*(b^0 + c) + a^0$. Notice now that as c converges to zero, d is accordingly adjusted to maintain the equilibrium at (p^*, q^*). That is, demand becomes more inelastic at (p^*, q^*): the elasticity of demand at (p^*, q^*), denoted $\eta_D(p^*)$, is given by $\eta_D(p^*) = [(cp^*)/(d - cp^*)$; thus, as c goes to zero with $d = d(c)$, p^* remains constant and so $\eta_D(p^*)$ goes to zero.[9] Graphically, this is equivalent to the demand curve becoming steeper at the free market equilibrium. Figure 6.4

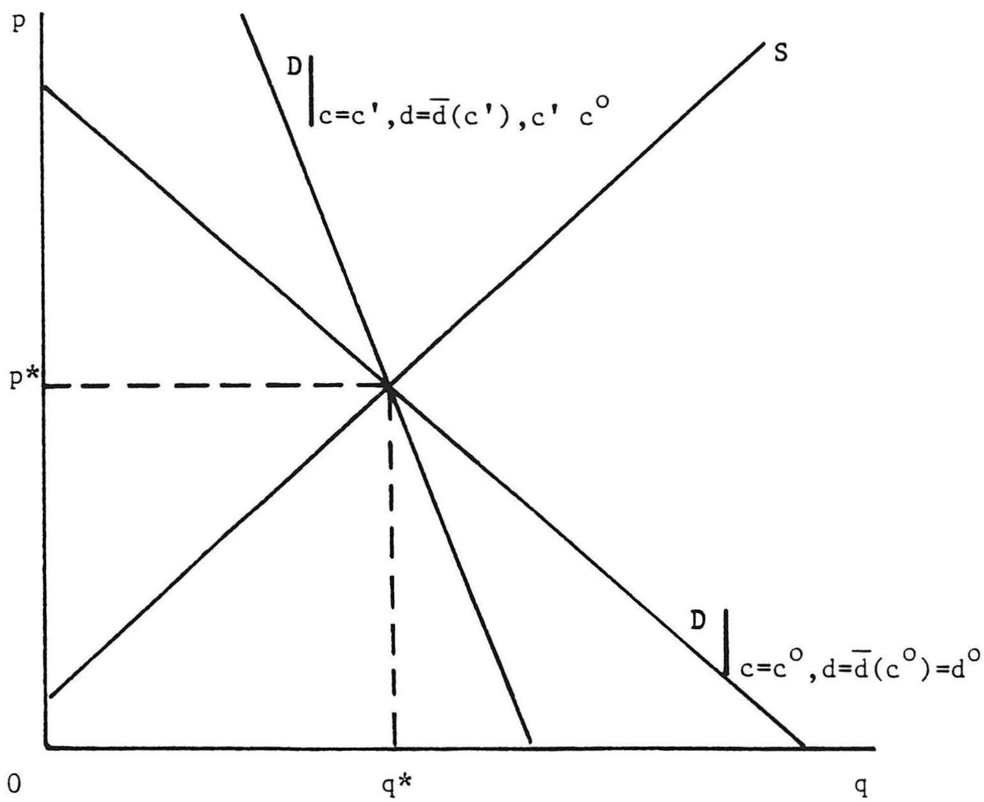


FIGURE 6.4

illustrates this. From here on, we assume $d = \bar{d}(c)$.

From Figure 6.2, it is easy to see that a production quota would be politically disastrous if demand were elastic at the equilibrium—$G_2(\bar{p}) < 0$ and $L_2(\bar{p}) > 0$ for any $\bar{p} > p^*$; that is, both producers and consumers will be worse off. Thus, given that he has a negatively significant proportion of farmers in his constituency, the legislator would choose a price floor. This is the point of the first proposition.

PROPOSITION 6.1:

There exists a sufficiently large $\tilde{c}$ ($\tilde{c} > 0$), an $\tilde{M}_j$, and an $\tilde{N}_j$ such that $\Delta_{1,2} > 0$.

Proof:

From above,

$$G_2(\bar{p}) = [\bar{p} - h^{-1}(f(\bar{p}))]f(\bar{p}) - \int_{h^{-1}(f(\bar{p}))}^{p^*} h(p)dp = [\bar{p} - h^{-1}(f(\bar{p}))]f(\bar{p}) + \int_{p^*}^{h^{-1}(f(\bar{p}))} h(p)dp .$$

So, for any fixed $\bar{p}$,

$$\frac{\partial G_2}{\partial \bar{p}} = (1 - (h^{-1})'f')f(\bar{p}) + (\bar{p} - h^{-1}(f(\bar{p})))f' + f(\bar{p})$$

$$= (1 - (f'/h'))f(\bar{p}) + f(\bar{p}) + (\bar{p} - h^{-1}(f(\bar{p})))f' .$$

Now $f' = -c$, $h' = b$, and $h^{-1}(f(\bar{p})) = ((f(\bar{p}) - a)/b)$. Hence,

$$\frac{\partial G_2}{\partial \bar{p}} = (2 + \frac{c}{b})f(\bar{p}) - c[\bar{p} - ((f(\bar{p}) - a)/b)]$$

$$= (\frac{c}{b})[2f(\bar{p}) + 2(\frac{b}{c})f(\bar{p}) - (b\bar{p} + a)]$$

$$= (\frac{c}{b})[2(1 + \frac{b}{c})f(\bar{p}) - \overline{h(\bar{p})}] .$$

Let $d = \bar{d}(c)$, then, for any $\bar{p}$, $\lim_{c \to \infty+} \left[\frac{\partial G_2}{\partial \bar{p}} \right] = \infty-$. Hence, $\exists$ some $\tilde{c} > 0$ such that $(\partial G_2/\partial \bar{p}) < 0$. Furthermore, for any $\varepsilon > 0$, $\frac{\partial G_2}{\partial \bar{p}}(\bar{p} + \varepsilon) < 0$ if $\frac{\partial G_2}{\partial \bar{p}}(\bar{p}) < 0$. Now, let

$\bar{p} = (p^* + \delta)$ where $\delta > 0$. Then, $(\partial G_2/\partial\bar{p}) < 0 \ \forall \ \bar{p} \in [p^* + \delta, \infty +)$ provided $c \geq \tilde{c}$. Choose δ to be infinitesimally small, then $(\partial G_2/\partial\bar{p}) < 0 \ \forall \ \bar{p} \in (p^*, \infty +)$. Since $G_2(p^*) = 0$ then it follows that, if $c \geq \tilde{c}$, $G_2(\bar{p}) < 0 \ \forall \ \bar{p} \in (p^*, \infty +)$. Moreover, since $L_2(\bar{p}) > 0$ always then $Q_{j,2}(\bar{p}) < 0 \ \forall \ \bar{p} \in (p^*, \infty +)$, i.e., $\hat{p}_j^2 = p^*$. Now pick any $\bar{p} > p^*$ and suppose $M_j \delta_w^j(\bar{G}_1(\bar{p})) - N_j \delta_c^j(\bar{L}_1(\bar{p})) \leq 0$. We can always choose $\tilde{M}_j, \tilde{N}_j$ such that $\tilde{M}_j \delta_p^j(\bar{G}_1(\bar{p})) - N_j \delta_c^j(\bar{L}_1(\bar{p})) > 0$. Since $Q_{j,1}(\bar{p}) > 0$ at $\tilde{M}_j$ and $\tilde{N}_j$ and $Q_{j,1}(p^*) = 0$ for any M_j and N_j then $\hat{p}_j^1 > p^*$. Thus, if $c = c^0, M_j = \tilde{M}_j, N_j = \tilde{N}_j$ then $\Delta_{1,2} = Q_{j,1}(\hat{p}_j^1(\mu_1^j); \mu_1^j) - Q_{j,2}(\hat{p}_j^2(\mu_2^j); \mu_2^j) > 0$. □

The next proposition is not as straightforward. In effect, it states that if demand is sufficiently inelastic at the equilibrium, then the legislator will choose a production quota. More precisely, it can easily be shown that for any fixed $\bar{p}$ in $[p^*, p_m]$, $G_1(\bar{p}) > G_2(\bar{p})$ and $L_1(\bar{p}) > L_2(\bar{p})$. Hence, it is not clear whether $Q_{j,1}(\bar{p})$ is greater than, equal to, or less than $Q_{j,2}(\bar{p})$. That is, $M_j \delta_w^j(\bar{G}_1(\bar{p})) > M_j \delta_w^j(\bar{G}_2(\bar{p}))$ and $N_j \delta_l^j(L_1(\bar{p})) > N_j \delta_l^j(L_2(\bar{p}))$. Notice, though, that if for some support level $\bar{p}$ chosen for instrument 1, we can find a support level $\tilde{p}\,(\bar{p})$ corresponding to instrument 2 such that,

$$G_2(\tilde{p}\,(\bar{p})) = G_1(\bar{p}) \tag{6.9a}$$

$$L_2(\tilde{p}\,(\bar{p})) < L_1(\bar{p}) \tag{6.9b}$$

then clearly, $Q_{j,2}(\tilde{p}\,(\bar{p})) > Q_{j,1}(\bar{p})$. In particular, if we can find such a support level corresponding to $\hat{p}_j^1$, denoted $\tilde{p}\,(\hat{p}_j^1)$, then $\Delta_{1,2} < 0$ so that the legislator will choose instrument 2: $Q_{j,1}(\hat{p}_j^1(\mu_1^j); \mu_1^j) < Q_{j,2}(\tilde{p}\,(\hat{p}_j^1(\mu_1^j))) \leq Q_{j,2}(\hat{p}_j^2(\mu_2^j); \mu_2^j)$; the first inequality follows from the above conditions and the second from the definition of $\hat{p}_j^2$. We can do this if c is sufficiently close to zero, i.e., $\eta_D\,(p^*; c, \bar{d}(c))$ is close to zero.

PROPOSITION 6.2:

There exists a sufficiently small c^* ($c^* > 0$) such that, for any $c \in (0, c^*]$, conditions (6.9a) and (6.9b) are satisfied at $\bar{p} = \hat{p}_j^1(\mu_1^j)$ where $\mu_1^j = (a^0, b^0, c, \bar{d}(c), s, M_j\, N_j, M, N)$.

Proof: See the Appendix.

The conditions (6.9a) and (6.9b) have an interesting interpretation. In effect, they state that given the support levels $\bar{p}$ and $\tilde{p}$ ($\bar{p}$) chosen for the price floor and the quota, respectively, farmers would be indifferent between the two instruments, since their gain is the same under each (6.2a), but consumers would prefer the quota, since their loss would be smaller (6.2b). Proposition 6.2 states that this is the case for corresponding support levels $\hat{p}_j^1$ and $\tilde{p}$ ($\hat{p}_j^1$) provided demand is sufficiently inelastic at the free market equilibrium; it thus implies that $\Delta_{1,2} < 0$.

The idea behind the proof of Proposition 6.2 can be explained intuitively. In Figure 6.5, I have etched out an arbitrary compact set $[p^*, p^{**}]$ along the vertical axis. The gain under instrument 1 at a price support level of p^{**} is $(A + B + C + D)$. If the demand curve is steep enough at (p^*, q^*) as shown in Figure 6.5, then there will be some support level $\tilde{p}$ (p^{**}) higher than p^{**} such that the gain under instrument 2 at that support level will be the same: $(J + A - H - I)$ is more or less equal to $(A + B + C + D)$. Notice also that the loss under instrument 1, $(A + B + C + D + E + F + I +$ storage costs), will still be larger than the loss under instrument 2, $(A + B + C + J + K)$[10]. In fact, these properties will hold for all support levels chosen for instrument 1 that are in the set $(p^*, p^{**}]$: for all $\bar{p} \in (p^*, p^{**}]$, $\exists\ \tilde{p}$ ($\bar{p}$) such that (6.9a) and (6.9b) are satisfied. Furthermore, the higher p^{**} (the larger the set), the closer c^* must be to zero; that is, demand must be more inelastic at (p^*, q^*). I depict this in Figure 6.6. Finally, note that $\hat{p}_j^1$ depends on the values of c and d (since $d = \bar{d}(c)$ by assumption then it effectively depends on c). It can be shown that $\hat{p}_j^1$ falls as c increases.[11] Thus, $\hat{p}_j^1(0) > \hat{p}_j^1(c)$ for

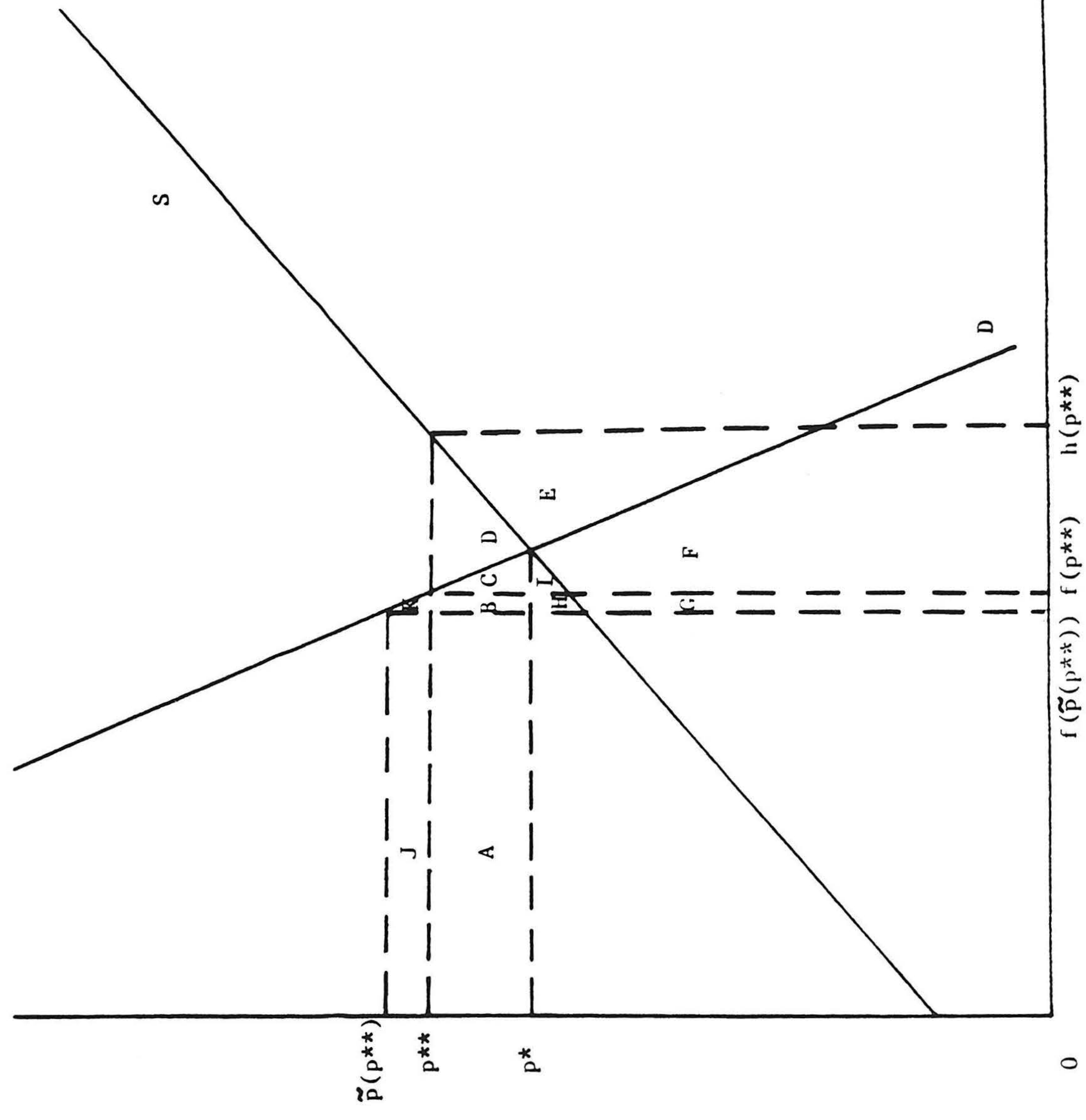


FIGURE 6.5

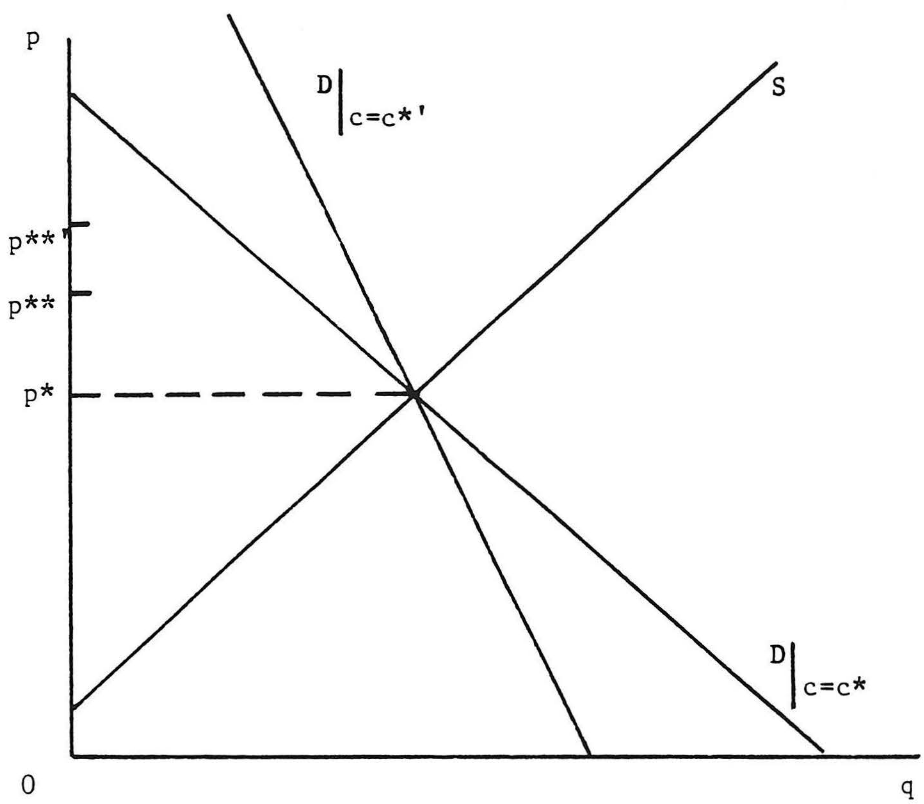


FIGURE 6.6

all $c > 0$. Now, if I set p^{**} equal to $p_j^1(0)$ then there will be some $c^* > 0$ such that the above properties will be satisfied for all $\bar{p}$ in $(p^*, \hat{p}_j^1(0))$ and in particular for $p^1(c^*)$. Now, the same is true for all c in $(0, c^*]: p^* \leq \hat{p}_j^1(c) < \hat{p}_j^1(0)$ and (6.9a) and (6.9b) are satisfied at $\hat{p}_j^1(c)$. Consequently, the legislator will stand to gain more in expected votes if he chooses instrument 2.

Analogous results can be derived for supply elasticity at the free market equilibrium. Since the method of proof is the same,I will state them without proof.

PROPOSITION 6.3:

Define $\bar{a}(b) \equiv (d - (b + c)p^*)$ and let $a = \bar{a}(b)$. Then there exist $\tilde{b}$, $b^* > 0$ such that $\Delta_{1,2} > 0$ if $b \leq b^*$ and $\Delta_{1,2} < 0$ if $b \geq \tilde{b}$.

Figures 6.7a and 6.7b provide the intuition for this proposition. The more elastic supply is at the equilibrium (the larger b is) the greater the gain to farmers under a quota—$(A - G)$ increases; moreover, consumers are unaffected since $(A + B)$ is unaffected. On the other hand, under a price floor, the increased gain to farmers due to an increased supply elasticity is offset by the increased loss to consumers. The producer surplus increases, but at the same time the cost of the surplus $(B + C + D + E + F)$, not to mention the increased storage costs, also increases. Hence, the more elastic supply is at the equilibrium, the more politically attractive a quota is.

From Proposition 6.1 there is some c such that $\Delta_{1,2} > 0$ and from Proposition a some $\tilde{c}$ $(< c)$ such that $\Delta_{1,2} < 0$. Since $Q_{j,1}$ and $Q_{j,2}$ are continuous in c, then it follows that there is some $\bar{c}$ such that $\Delta_{1,2} = 0$.[12] In short, there exist values of the parameters such that the legislator is indifferent between the two instruments. Assume that the parameters initially take on these values. By performing some comparative statics on $\Delta_{1,2}$, one can then determine whether a change in some parameter induces the legislator to choose one or the other instrument.

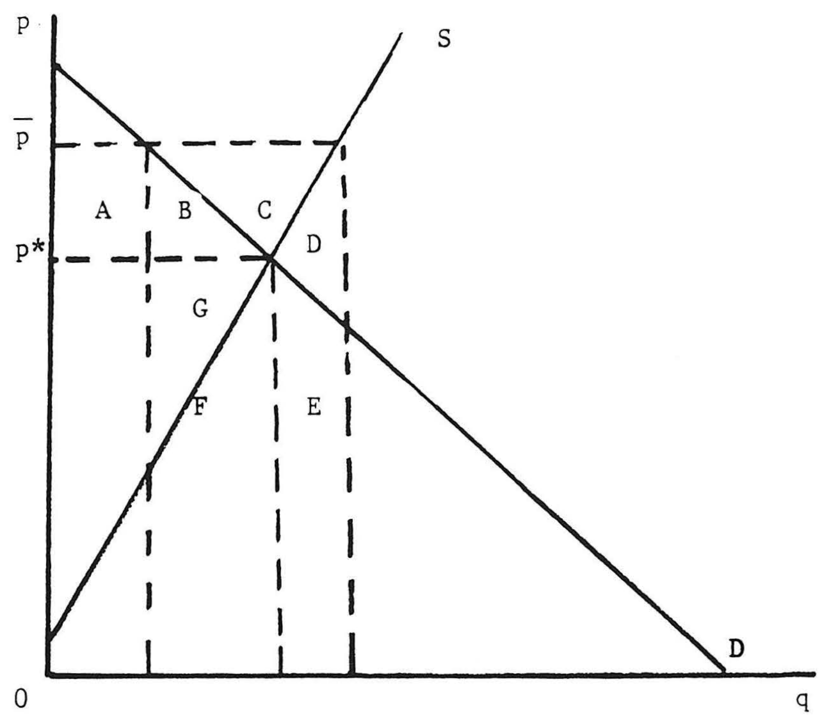


FIGURE 6.7 a

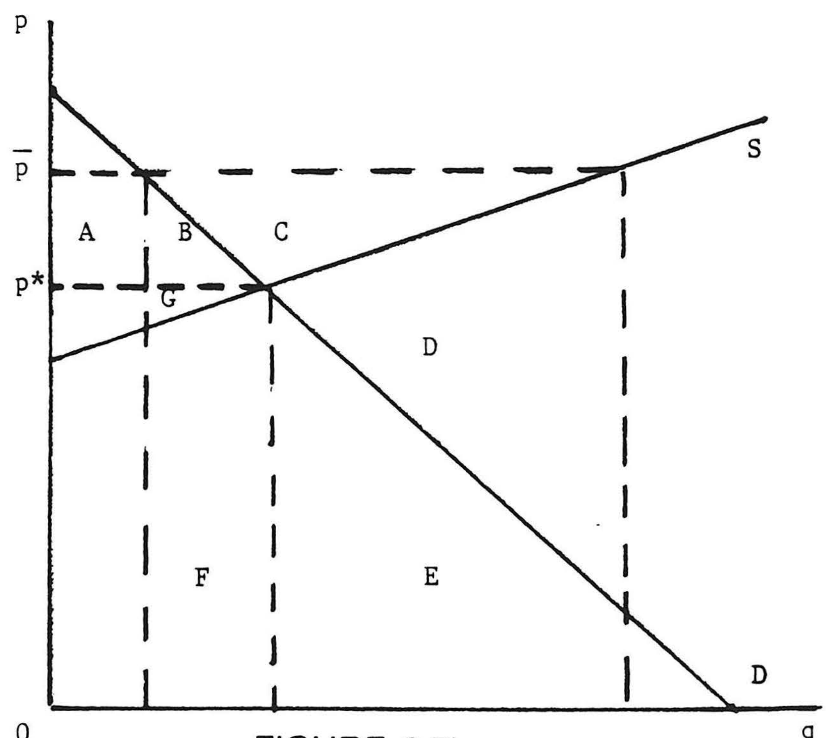


FIGURE 6.7b

By the envelope theorem,

$$\frac{\partial \Delta}{\partial m} = \frac{\partial \hat{Q}_{j,1}}{\partial m}\Big|_{\bar{p}=\hat{p}_j^1} - \frac{\partial \hat{Q}_{j,2}}{\partial m}\Big|_{\bar{p}=\hat{p}_j^2}.$$

where $\hat{Q}_{j,}\, i \equiv \max_{\bar{p}} Q_{j,1}(\,\cdot\,;\mu_i^j)$ and m a scalar parameter. One can use this to determine how $\Delta_{1,2}$ changes in response to changes in selected parameters.

PROPOSITION 6.4:

$$\frac{\partial \Delta_{1,2}}{\partial s} < 0.$$

Proof: Trivial.

This proposition implies that the legislator will choose instrument 2 if the cost of maintaining the surplus rises. However, it has an alternative interpretation. Recall that I have assumed that the surplus is to be stored for only one period and thereafter given away (see footnote 1). Suppose I let t be the number of periods that the surplus is to be stored. Then, total storage cost would be $(s \cdot t)(h(\hat{p}_j^1) - f(\hat{p}_j^1))$ with $t = 1$. If t rises then so does the storage cost. Now let t^0 represent the initial length of time that the surplus is to be stored and define $\tilde{s} \equiv (s \cdot t^0)$. Assuming s is constant then Proposition 6.4 implies that the legislator will choose instrument 2 if t^0 rises, i.e., $(\partial \Delta_{1,2} / \partial \tilde{s}) < 0$.

During the period 1952-1965, technological change as reflected in rising yields per acre was the principal factor affecting the price support programs; from 1965 to 1972, redistricting was a major political variable that shaped the programs. It would thus be interesting to see what the model has to say about the impact of these variables.

Technological improvement manifests itself as a downward shift in the supply curve or equivalently as an increase in supply. A rise in supply in turn leads to a fall in the free market price and an increase in the free market quantity. In the absence of any price support program, the price paid by consumers falls. However, with either a price floor or a quota, the consumer price remains the same. More important, though, is that under a quota consumers fail to recognize that they could in fact have paid a lower price if there were no support program. That is, at least in the short run, consumers do not know whether producers have acquired new technology and so are unaware of any potential gains that would accrue from a lower free market price. This information asymmetry can be reflected in the model by simply assuming that $\partial(N_j \delta/(I_2))/\partial a$ is zero. That is, under a quota consumers do not react to foregone benefits of technological change.

With a price floor, consumers will know that their loss has increased if new technology is adopted. They can observe the size of the surplus. If it increases,then they know that their tax loss must have increased and could infer that they could have paid an even lower price in the absence of the floor. In other words, there is no (or perhaps less) information asymmetry under a price floor.

Besides pushing the free market price downward, an increase in supply will force the government to increase it's own holdings of the commodity, i.e., the surplus, if a price floor were the chosen means of support. That is, the government would have to actively intervene in the market. Since consumers can observe changes in the surplus, one would expect the gains and losses resulting from this to be politically sensitive. In fact, historically, the debates in Congress focused heavily on the burden of the surplus (Congressional Quarterly Almanac, 1952-1965).

Under a quota, consumers do not react to the effect of technological change. Producers, on the the other hand, do, since they gain; new technology leads to lower production costs and thus to increased profits. The increase in profits is illustrated in Figure 6.8a.

The preceding discussion suggests that technological change biases a legislator's choice toward a quota. Under a quota, consumers do not observe the increased loss, and at the same

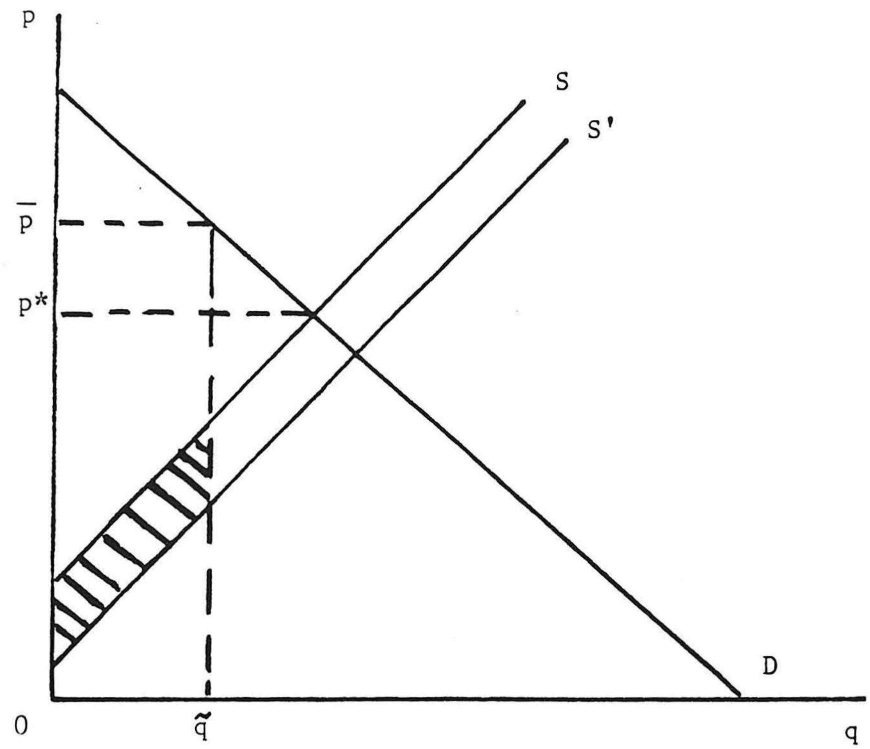


FIGURE 6.8 a

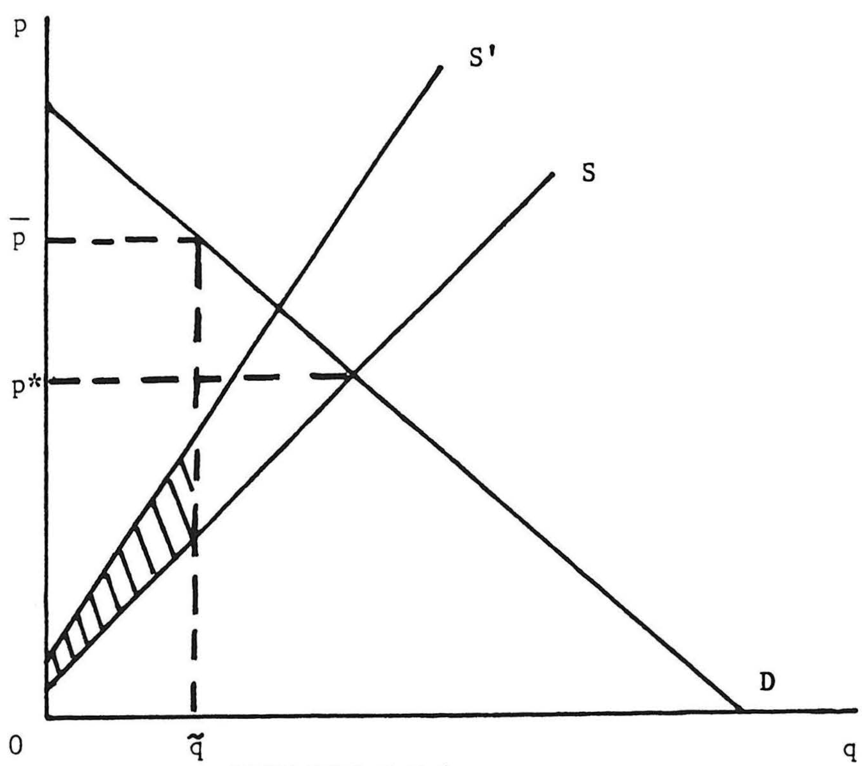


FIGURE 6.8 b

time producers gain. On the other hand, under a price floor, consumers observe an increase in the surplus and thus will react accordingly. Consequently, the vote gains from producers are offset by the vote loss to consumers. I state this formally in the next proposition.

PROPOSITION 6.5:

There exists an $\varepsilon > 0$ such that, for all $b \in (0, c + \varepsilon)$, $(\partial \hat{Q}_{j,1}/\partial a) < 0$.

Proof:

$$\frac{\partial \hat{Q}_{j,1}}{\partial a} = M_j \delta_p^{j'} \frac{\partial \bar{G}_1}{\partial a} - N_j \delta_p^{j'} \frac{\partial \bar{L}_1}{\partial a} .$$

It can easily be shown that,

$$\frac{\partial \bar{G}_1}{\partial a} = \frac{1}{M} [(\hat{p}_j^1 - p^*) + \frac{h(p^*)}{(b+c)}] \text{ and } \frac{\partial \bar{L}_1}{\partial a} = \frac{1}{N} [(\hat{p}_j^1 + s) + \frac{f(p^*)}{b+c}] .$$

From the first order condition,

$$\frac{M_j \delta_w^{j'}}{N_j \delta_l^{j'}} = \left[\frac{M}{N}\right] \left[\frac{\bar{L}_1'}{\bar{G}_1'}\right] = \left[\frac{M}{N}\right] \left[\frac{(\hat{p}_j' + s)(b-c) + h(\hat{p}_j^1)}{h(\hat{p}_j^1)}\right] .$$

Thus, $\frac{M_j \delta_w^{j'}}{N_j \delta_l^{j'}} \leq \left[\frac{M}{N}\right]$ if $b \leq c$. Now, $\frac{\partial \hat{Q}_{j,1}}{\partial a} < 0$ if and only if

$$\frac{M_j \delta_w^{j'}}{N_j \delta_l^{j'}} < \left[\frac{M}{N}\right] \left[\frac{(\hat{p}_j^1 + s) + (f(p^*)/(b+c))}{(\hat{p}_j^1 - p^*) + (h(p^*)/(b+c))}\right] .$$

Since $f(p^*) = h(p^*)$ then the *RHS* is greater than (M/N) and since the *LHS* is at most equal to (M/N) then $(\partial \hat{Q}_{j,1}/\partial a) < 0$ if $b \leq c$. By continuity, there exists some $\varepsilon > 0$ such that, for all $b \in (c, c + \varepsilon)$,

$$\frac{(\hat{p}_j^1 + s)(b-c) + h(\hat{p}_j^1)}{h(\hat{p}_j^1)} < \left[\frac{(\hat{p}_j^1 + s) + (f(p^*)/(b+c))}{(\hat{p}_j^1 - p^*) + ((h(p^*)/(b+c))}\right] . \square$$

What this proposition in effect implies, is that by choosing instrument 2, the legislator could avoid magnifying an already politically sensitive issue—the cost of maintaining the surplus—and still provide some support for farmers. To see this, note that

$(\partial \hat{Q}_{j,2}/\partial a) = \frac{\partial}{\partial a}(M_j \delta_w^j(\bar{G}_2(\hat{p}_j^2))) - \frac{\partial}{\partial a}(N_j \delta_l^j(\bar{L}(\hat{p}_j^2)))$. Since the second term on the right hand side is zero (by assumption), and the gains to producers increase as a increases, then $(\partial \hat{Q}_{j,2}/\partial a)$ is positive. Consequently, $(\partial \Delta_{1,2}/\partial a)$ is negative.

An increase in the surplus brought about, say, by the adoption of new technology can be offset by restrictions on input usage. The analysis of the impact of such restrictions proceeds in a similar fashion. A restriction on inputs tilts supply upward; analytically, it is represented by a fall in b. If a quota were the method of support, its effect would not be observed by consumers. If instead a price floor were in effect, the consequent contraction of the surplus would be observed by consumers. Again, an information asymmetry exists. To accommodate this, I assume $(\partial(N_j \delta_l^j(\bar{L}_2))/\partial b)$ is zero.

PROPOSITION 6.6:

There exists a $\gamma > 0$ such that for all $b \in (0, c + \gamma)$, $(\partial \hat{Q}_{j,1}/\partial b) < 0$.

Proof:

$$\frac{\partial \hat{Q}_{j,1}}{\partial b} = M_j \delta_w^{j\prime} \frac{\partial \bar{G}_1}{\partial b} - N_j \delta_l^{j\prime} \frac{\partial \bar{L}_1}{\partial b} .$$

Now,

$$\frac{\partial \bar{G}_1}{\partial b} = \frac{1}{2}(\hat{p}_j^2 - p^{*2}) + \frac{h(p^*)p^*}{(b+c)} \quad \text{and} \quad \frac{\partial \bar{L}_1}{\partial b} = \hat{p}_j^2 + s\bar{p} + \frac{f(p^*)p^*}{(b+c)} .$$

From the first order condition, if $(b - c) \leq 0$, then,

$$\frac{M_j \delta_w^{j\prime}}{N_j \delta_l^{j\prime}} < \frac{M}{N} .$$

Since $f(p^*) = h(p^*)$ then

$$\frac{M}{N} < \left[\frac{M}{N}\right] \frac{(\partial \bar{L}_1/\partial b)}{(\partial \bar{G}_1/\partial b)} = \left[\frac{M}{N}\right] \left[\frac{\hat{p}_j^2 + \hat{p}_j^2 + (f(p^*)p^*)/(b+c)}{\frac{1}{2}(\hat{p}_j^2 - p^{*2}) + h(p^*)p^*)/(b+c)} \right].$$

This implies that $(\partial \hat{Q}_{j,1}/\partial b) < 0$ if $(b - c) \leq 0$. The conclusion follows then from continuity of $\hat{Q}_{j,1}$ in b. □

Figure 6.8b shows quite clearly that producers' gains under a quota fall if input restrictions are imposed. Since $(\partial(N_j \delta_j^{\prime}(\bar{L}_2))/\partial b)$ is zero, then this means $(\partial \hat{Q}_{j,2}/\partial b)$ is positive. Proposition 6.6 thus implies that $(\partial \Delta_{1,2}/\partial b)$ is negative, i.e., the imposition of input restrictions biases the choice toward a price floor.

Propositions 6.4 and 6.5 suggest that changes in the surplus trigger changes in the degree of control over production. An increase in the surplus leads to a greater degree of control and a decline to a lesser degree. Proposition 6.6 then suggests that once the appropriate level of controls are in place, a price floor can be politically maintained as the method of support.

So far I have dealt only with changes in economic parameters. I now turn to the effect of changes in certain political parameters on a legislator's choice. Proposition 6.7 states that, given a quota is the instrument used, a decline in the number of producers relative to the number of consumers in a legislator's district will induce the legislator to lower the quota equivalent price support, which in turn suggests that the legislator would prefer to relax restrictions on production.

PROPOSITION 6.7:

$(\partial \hat{p}_j^2/\partial N_j) < 0$ and $(\partial \hat{p}_j^2/\partial M_j) > 0$.

Proof:

First note that, by the implicit function theorem, for any parameter m,

$$\frac{\partial \hat{p}_j^i}{\partial m} = -\frac{(\partial Q'_{j,i}/\partial m)}{Q''_{j,i}} .$$

Since $Q''_{j,i} < 0$ then $sign(\partial \hat{p}_j^i/\partial m) = sign(\partial Q'_{j,i}/\partial m)$. It follows then that

$$\frac{\partial Q'_{j,2}}{\partial N_j} = -(\delta_l^{j'}\bar{L}'_2) < 0 \text{ and } \frac{\partial Q'_{j,2}}{\partial M_j} = (\partial_w^{j'}\bar{G}'_2 > 0 . \square$$

Producers need not necessarily be a cohesive group. The same is true for consumers. The cohesiveness of either group is reflected by the probability vote functions δ_w^j and δ_l^j; the less cohesive the group, the lower the value of the vote function at any given per capita gain $\bar{G}$ or per capita loss $\bar{L}$.[13] The next proposition suggests that a legislator would prefer less control over production the less cohesive producers (or the more cohesive consumers) are.

PROPOSITION 6.8:

$$\frac{\partial \hat{p}_j^2}{\partial \delta_w^{j'}} > 0 \text{ and } \frac{\partial \hat{p}_j^2}{\partial \delta_l^{j'}} < 0 .$$

Proof:

$$\frac{\partial \hat{p}_j^2}{\partial \delta_w^{j'}} = M_j\bar{G}'_2 > 0 \text{ and } \frac{\partial \hat{p}_j^2}{\partial \delta_l^{j'}} = -N_j\bar{L}'_2 < 0 . \square$$

In this chapter I have constructed a political economy model of instrument choice in the regulation of markets and have used it to analyze the choice between a price floor and a production quota in the implementation of a price support program. I show that both economic and political variables and/or changes therein affect a legislator's choice between the two. In the next section I will present some anecdotal evidence supportive of the implications of Propositions 6.4, 6.5 and 6.6. In the next chapter I will present statistical evidence attesting to or rejecting these implications as well as implications of the other propositions.

C. Some Empirical Evidence

A price floor was the basic method used to support feed grains and wheat prices during the period 1952 to 1965.[14] Hence, the period 1952-1965 provides a fertile ground for evaluating the consistency of Propositions 6.4 and 6.5 with actual events. I should note that in no other period after World War II was a price floor adopted as the support instrument.

From Table 6.2 below, observe that the acreage planted to corn each year from 1953 to 1960 remained more or less constant. On the other hand, yield per acre rose consistently. The average per acre yield the first half of the period was 35.8 and in the second half 45.7, an increase of 27.6% (the same trends characterized the other feed grains—sorghum, barley, oats). Clearly, this implied an increase in supply due to technological change.[15] From Propositions 6.4, 6.5, and 6.6 one would predict that some form of effective control on production would be imposed. In fact, there was indeed a shift in the predicted direction. Effective quantity restrictions were imposed beginning in 1961. In 1961, the Kennedy administration proposed stiff production controls in conjunction with price support programs. "The basic objectives of the program were (1) to raise farmer income and (2) to reduce government costs. The technique to achieve these ends was 'supply management'—a stringent system of sales and production quotas that would prevent surpluses from reaching the market thereby driving farm market prices above support levels. The quotas were to be based on an individual farmer's history of production. The increase in price would mean few Government price-support acquisitions would be necessary, and therefore CCC (Commodity Credit Corporation) would not acquire expensive inventories with heavy carrying costs."[16] This reflected the rise in opposition to the price support program, due basically to the excessive buildup in the surplus (as indicated in Table 6.2). Although the proposal was defeated in Congress, a weaker form of quantity restriction was implemented. "The Kennedy administration lost its fight for strict mandatory

TABLE 6.2

	CORN			WHEAT		
Year	Acreage	Yield/Acre	End of Year Carryover Stocks	Acreage	Yield/Acre	End of Year Carryover Stocks
1953	81.5	35.4	920	78.9	14.9	933.5
1954	82.2	32.9	1,035	62.5	15.7	1,036.2
1955	80.9	35.5	1,165	58.2	16.1	1,033.5
1956	77.8	39.5	1,419	60.6	16.6	908.8
1957	73.2	41.6	1,469	49.8	19.2	881.4
1958	73.3	46.8	1,524	56.0	26.0	1,295.1
1959	82.7	46.3	1,787	56.7	19.7	1,313.4
1960	81.4	48.0	2,016	54.9	24.7	1,411.3
1961	65.9	54.6	1,653	55.7	22.1	1,322.0
1962	65.0	55.5	1,365	49.3	22.1	1,195.2
1963	68.8	58.4	1,537	53.4	21.5	901.4
1964	65.8	52.9	1,147	55.7	23.0	817.3
1965	65.1	63.0	840	57.4	22.9	535.2

controls in which government costs of farm programs might be reduced significantly. But in losing, it pioneered a system of voluntary controls, which were workable in he sense that (1) they were acceptable and (2) they had the capacity to reduce production. The experience in the Kennedy years further demonstrated that any farm policy which seeks to hold farm prices and incomes above equilibrium levels must, if it is to be continued over a period of years, have coupled with it a system of effective supply management devices."[17] In the years following 1961, the surplus was gradually reduced.

The data for wheat also supports the prediction. Except for the years 1956 and 1957, when export demand was unusually strong, the surplus increased from 933.5 million bushels in 1953 to 1.41 billion bushels in 1960. Planted acreage fell continuously during the period,but yield per acre increased by about 65%, thereby offsetting the potential reduction in the surplus that the decrease in acreage could have generated. As mentioned earlier, quantity restrictions were imposed beginning in 1961.

In this chapter, I constructed a political economy model of instrument choice and used it to analyze the choice between a price floor and a production quota in the implementation of a price support program. I argued that demand and supply elasticities at equilibrium affect a legislator's choice between the two instruments and I go on to show that changes in certain parameters, both economic and political, result in a bias toward one instrument or the other. In the next chapter, I will present stronger evidence attesting to the model's credibility.

FOOTNOTES TO CHAPTER 6

1. Hansen (1986), pp. 4.

2. Sampson and Farris (1975), pp. 347.

3. For a justification, see Chapter 4, footnote 16.

4. This is meant to reflect in part the differences in the incidence of benefits and costs across different parts of the country.

5. Note that $\hat{Q}_{j,i}(\mu_i^j) = Q_{j,i}(t_j^i(\mu_i^j); \mu_i^j)$.

6. By the envelope theorem,
$$\frac{\partial \hat{Q}_{j,i}}{\partial m} = \frac{\partial Q_{j,i}}{\partial m}\bigg|_{t=t_j^i}.$$

7. I assume that consumers shoulder the whole tax burden of the surplus and, at least initially, that the surplus is given away after one period. Note too that I have expressed the gain and loss functions in terms of the price support level $\bar{p}$. I can also do this in terms of a unit tax. Let $t = (\bar{p} - p^*)$. Then I can derive the functions in terms of t by substituting $(t + p^*)$ for $\bar{p}$. That is, $G(\bar{p}) = G(t + p^*)$ and $L(\bar{p}) = L(t + p^*)$.

8. More precisely, by the implicit function theorem, there exists a neighborhood **N** such that, for all $\mu_i^j \in$ **N**,
(i) $\hat{p}_j^i = \hat{p}_j^i(\mu_i^j)$ and
(ii) $Q_{j,i}'(\hat{p}_j^i(\mu_i^j); \mu_i^j) = 0$.
Note that μ_1^j and μ_2^j differ only in s.

9. $\eta_D(p^*; c, \bar{d}(c)) = \dfrac{1}{\bar{d}(c)/cp^* - 1}$. Since $\lim_{c \to 0} \bar{d}(c) = (p^* b^0 + a^0)$ then $\lim_{c \to 0} \eta_D(p^*; c, \bar{d}(c)) = 0$.

10. Notice that the steeper the demand curve is at the equilibrium, the smaller the surplus and thus the lower its tax burden. Figure 5 shows that the lower tax burden is still larger than the potential additional loss to consumers under a quota, due to the higher support level: $(J + K) < (B + C + D + E + F + I) < (B + C + D + E + F + I +$ storage cost). Implicit in this is the assumption that consumers place at least equal weight on the loss due to the surplus as on the loss due to higher prices. In fact, congressional debates seem to indicate that a greater weight is put on the former (which makes our argument ever stronger).

11. As c rises the demand curve becomes flatter at the equilibrium, and thus the surplus increases. This increases the loss to consumers who then will increase their lobbying activities. To stymie the rise in opposition, the legislator must lower the support level given that he chooses to retain instrument 1 as the method of support.

12. Note that, at $c = \bar{c}$, demand is inelastic at the equilibrium. Otherwise, $\Delta_{1,2} < 0$.

13. A fall in $\delta_w^{i}(\delta_l^{i})$ results also in a fall in $\delta_w^{i'}(\delta_l^{i'})$.

14. During 1953-1960, acreage restrictions were also imposed occasionally in conjunction with a price floor. But these restrictions were ineffective or at best partially effective. The results of Propositions 6.4 and 6.5 can be interpreted as conditional on partially effective acreage restrictions being imposed under each instrument.

15. Domestic demand was relatively stable and exports insignificant during the period.

16. Cochrane and Ryan (1976), pp. 92.

17. Ibid, pp. 95.

18. Data is from Cochrane and Ryan (1976), pp. 179, 203.

19. $[G_2(\bar{p}; c, \bar{d}(c), a, b) - L_2(\bar{p}; c, \bar{d}(c), a, b) = \{-c(1 + \frac{c}{2b})\bar{p}^2 + \left[\frac{1}{b}\right][b\bar{d}(c) + (\bar{d}(c) - a)c]\bar{p}$
$+ [\frac{(a - \bar{d}(c))^2}{2b} - (ap^* + \frac{b}{2}p^{*2})]\} - \{-\frac{c}{2}\bar{p}^2 + \bar{d}(c)\bar{p} - (\bar{d}(c)p^* - \frac{c}{2}p^{*2})\}$
So, $\lim_{c \downarrow 0}[G_2(\bar{p}; c, \bar{d}(c), a, b) - L_2(\bar{p}; c, \bar{d}(c), a, b)]$

$$= \bar{d}(0)\bar{p} + \left[\frac{a}{b}\right]\bar{d}(0) - \left[\frac{1}{2b}\right](a^2 + \bar{d}(0)^2) - ap^* - \frac{b}{2}p^{*2} - \bar{d}(0)\bar{p} + \bar{d}(0)p^*$$
$$= \left[\frac{a}{b}\right](p^*b + a) - \frac{a^2}{2b} - \frac{(p^*b + a)^2}{2b} - ap^* - \frac{b}{2}p^{*2} + (p^*b + a)p^*$$
$$= ap^* + \frac{a^2}{2b} - \left[\frac{1}{2b}\right](p^{*2}b^2 + 2ap^*b + a^2) - ap^* - \frac{b}{2}p^{*2} + p^{*2}b + ap^*$$
$$= -\left[\frac{b}{2}\right]p^{*2} - \frac{b}{2}p^{*2} + bp^{*2} = 0.$$

20. This condition guarantees that there are values of c and s such that $Q_{j,1}(\hat{p}_j^1(c, \bar{d}(c), a, b, s); c, \bar{d}(c), a, b, s) > 0$. The choice problem is trivial unless such values exist.

APPENDIX TO CHAPTER 6

The route to the major proposition is long and somewhat difficult. Therefore, I will use a step-by-step approach, proving lemmas one at a time and using them to gradually build up to the proposition.

LEMMA 1:

For any $\bar{p} \in [p^*, \infty+)$,

(i) $G_1(p^*) = L_1(p^*) = L_2(p^*) = G_2(p^*) = 0$ and

(ii) $L_1(\bar{p}) > G_1(\bar{p}) > L_2(\bar{p}) > G_2(\bar{p})$ provided $\bar{p} \neq p^*$.

(iii) L_1, G_1 are strictly convex and strictly increasing in $\bar{p}$ and L_2, G_2 are strictly concave in $\bar{p}$ for all $c > 0$ and,

(iv) let $\hat{p} \equiv \underset{[p^*, \infty+)}{argmax}\, G_2(\cdot)$ and $p_u \equiv \underset{[p^*, \infty+)}{argmax}\, L_2(\cdot)$ then, $\exists$ an $\varepsilon > 0$ such that, for all $c \in (0, \varepsilon)$,

(a) $\hat{p} > p^*$

(b) $\hat{p} < p_m$

(v) G_1 and G_2 satisfy the following additional properties:

(a) $\exists$ a $p_u > p^*$ such that $G_1(p_u) = G_2(\hat{p})$;

(b) for any $\bar{p} \in [p^*, p_u]$, $\exists$ a $\tilde{p}$ such that $G_2(\tilde{p}) = G_1(\bar{p})$ with $\bar{p} < \tilde{p} \leq \hat{p}$ if $\bar{p} > p^*$ and $\tilde{p} = p^*$ if $\bar{p} = p_i^*$;

(vi) for any $\bar{p} \in [p^*, p_u]$, $\exists$ a $\tilde{p}\,'$ such that $G_2(\tilde{p}\,') = G_1(\bar{p})$ with $\tilde{p}\,' > \hat{p}$ if $\bar{p} \in [p^*, p_u)$ and $\tilde{p}\,' = \hat{p}$ if $\bar{p} = \hat{p}$;

(vii) given $c > 0$ then $\frac{d}{d\bar{p}}(L_2 - G_2) > 0$ for all $\bar{p} >> p^*$ and $\frac{d}{d\bar{p}}(L_2 - G_2) = 0$ if $\bar{p} = p^*$.

(viii) define $\bar{d}(c) \equiv p^*(b + c) + a$ and $\tilde{G}_2(\bar{p}; c, a, b) \equiv G_2(\bar{p}; c, \bar{d}(c), a, b)$ then $(\partial \tilde{G}_2 / \partial c) < 0$.

Proof:

(i) obvious.

(ii) this follows from the definitions of the gain and loss functions. More precisely, since $(h-f)' > 0$ then

$$\int_{p^*}^{\bar{p}} (h-f)dp = \int_{p^*}^{\bar{p}} (h(\bar{p})-f(\bar{p}))dp < (\bar{p}-p^*)(h(\bar{p})-f(\bar{p})) .$$

Hence,

$$L_1(\bar{p}) = \int_{p^*}^{\bar{p}} f(p)dp + (\bar{p}+s)(h(\bar{p})-f(\bar{p})) > \int_{p^*}^{\bar{p}} f(p)dp + (\bar{p}-p^*)(h(\bar{p})-f(\bar{p})) >$$

$$> \int_{p^*}^{\bar{p}} f(p)dp + \int_{p^*}^{\bar{p}} (h-f)dp = G_1(\bar{p})$$

and

$$G_1(\bar{p}) = \int_{p^*}^{\bar{p}} f(p)dp + \int_{p^*}^{\bar{p}} (h-f)dp > \int_{p^*}^{\bar{p}} f(p)dp = L_2(\bar{p}) .$$

Furthermore, since $f(\bar{p}) < h(p)$ and $f(\bar{p}) < f(p)$ for all $\bar{p} \in (h^{-1}(f(\bar{p})), p^*]$ then,

$$(p^* - h^{-1}(f(\bar{p})))f(\bar{p}) = \int_{h^{-1}(f(\bar{p}))}^{p^*} f(p)dp < \int_{h^{-1}(f(\bar{p}))}^{p^*} h(p)dp$$

and

$$(\bar{p}-p^*)f(\bar{p}) = \int_{p^*}^{\bar{p}} f(\bar{p})dp < \int_{p^*}^{\bar{p}} f(p)dp .$$

This implies that

$$L_2(\bar{p}) = \int_{p^*}^{\bar{p}} f(p)dp > (\bar{p}-p^*)f(\bar{p}) > \{(\bar{p}-p^*)f(\bar{p}) + [(p^* - h^{-1}f(\bar{p})))f(\bar{p}) - \int_{h^{-1}(f(\bar{p}))}^{p^*} h(p)dp]\}$$

$$= G_2(\bar{p}) .$$

(iii) $\frac{dL_1}{d\bar{p}} = 2(b + \frac{c}{2})\bar{p} + (a + (b + c)s) > 0$, $\frac{d^2L_1}{d\bar{p}^2} = 2(b + \frac{c}{2}) > 0$,

$\frac{dG_1}{d\bar{p}} = a + b\bar{p} > 0$, and $\frac{d^2G_1}{d\bar{p}^2} = b > 0$. Also, $\frac{d^2L_2}{d\bar{p}^2} = -c < 0$,

$\frac{d^2G_2}{d\bar{p}^2} = -2c(1 + \frac{c}{2b}) < 0.$

(iv) (a) $\frac{dG_2}{d\bar{p}} = -2c(1 + \frac{c}{2b})\bar{p} + (\frac{1}{b})[(b + c)d - ac]$ so that

$\hat{p} = (\frac{1}{2c})[((d - a)c + bd)/(b + 2c)]$. Now,

$$(\hat{p} - p_m) = (\frac{1}{2c})\left[\frac{(d - a)c + bd}{b + 2c}\right] - \left(\frac{d - a}{b + c}\right)$$

$$= \left[\frac{((d - a)c + bd)(b + c) - (d - a)2c(b + 2c)}{2c(b + 2c)(b + c)}\right].$$

Furthermore,

$$((d - a)c + bd)(b + c) - (d - a)2c(b + 2c)$$

$$= (d - a)c(b + c) + bd(b + c) - 2(d - a)c(b + c) - 2c^2(d - a)$$

$$= -(d - a)c(b + c) + bd(b + c) - 2c^2(d - a) =$$

$$= [ac + (b - c)d](b + c) - 2c^2d + 2ac^2 = ac(b + c)(b - c)d(b + c) - 2c^2d + 2ac^2$$

$$= ac(b + c) + 2ac^2 + [(b - c)(b + c) - 2c^2]d = ac(b + c) + 2ac^2 + [b^2 - 3c^2]d .$$

This is positive provided c is sufficiently close to 0.

(b) $\frac{dL_2}{d\bar{p}} = d - c\bar{p} = f(\bar{p}) = 0$ iff $\bar{p} = \frac{d}{c} \equiv p_M$. If $a \geq -3d$ and $c > 0$ then,

$$(\hat{p} - p_M) = \frac{d}{c} - \left[\frac{(\frac{1}{b})((d - a)c + bd)}{2c(1 + \frac{2c}{b})}\right]$$

$$= (\frac{1}{c})\left[d - \frac{((d - a)c + bd)}{2b(1 + \frac{2c}{b})}\right] = (\frac{1}{c})\left[\frac{d(2b)(1 + \frac{2c}{b}) - ((d - a)c + bd)}{2b(1 + \frac{2c}{b})}\right]$$

$$= \left[2bc\,(1 + \frac{2c}{b}) \right]^{-1} \left[2db\,(1 + \frac{2c}{b}) - (d - a)c - bd \right]$$

$$= \left[2bc\,(1 + \frac{2c}{b}) \right]^{-1} [bd + (3d + a)c\,] > 0\,. \;\square$$

(v) (a) $G_1(p^*) = 0$ and $G_2(\hat{p}) > 0$. Since G_1 is continuous and strictly increasing on (p^*, ∞^+) then there must necessarily be a price $p_u \in (p^*, \infty^+)$ such that $G_1(p_u) = G_2(\hat{p})$.

(b) Given $\bar{p} \in [p^*, p_u]$ and $G_1' > 0$ on (p^*, ∞^+) then $G_1(\bar{p}) \le G_1(p_u)$.

Since $G_1(p_u) = G_2(\hat{p})$ then, for $\bar{p} \in (p^*, p_u)$, $G_2(\hat{p}) > G_1(\bar{p}) \ge G_1(p^*) = 0$. Since $G_2' > 0$ on $(p^*, \hat{p})$ and $G_2(p^*) = 0$ then $\exists$ a $\tilde{p} \in (p^*, \hat{p})$ such that $G_2(\tilde{p}) = G_1(\bar{p})$. Since $G_1 > G_2$ then it follows that $\tilde{p} > \bar{p}$. Now if $\bar{p} = p^*$ then, since $G_2(p^*) = G_1(p^*) = 0$, $\tilde{p} = p^*$ and if $\bar{p} = p_u$ then, since $G_2(\hat{p}) = G_1(p_u)$, $\tilde{p} = \hat{p}$.

(vi) This follows from the fact that G_2 is strictly concave on $[p^*, \infty^+)$ and $G_2(\hat{p}) > 0$, i.e., G_2 is an upside-down parabola with a positive peak on $[p^*, \infty^+)$.

(v) $L_2(\bar{p}) - G_2(\bar{p}) = \{-\frac{c}{2}\bar{p}^2 + d\bar{p} - (dp^* - \frac{c}{2}p^{*2})\}$

$$-\{-c\,(1 + \frac{c}{2b})\bar{p}^2 + (\frac{1}{b})[(b + c)d - ac\,]\bar{p} + \left[\frac{(a - d)^2}{2b} - (ap^* + \frac{b}{2}p^{*2}) \right] \}\,.$$

So,

$$\frac{d}{d\bar{p}}(L_2(\bar{p}) - G_2(\bar{p})) = (-c\bar{p} + d) - \{-2c\,(1 + \frac{c}{2b})\bar{p} + \frac{1}{b}[(b + c)d - ac\,]\}$$

$$= [-c + 2c\,(1 + \frac{c}{2b})]\bar{p} + d - \frac{1}{b}[(b + c)d - ac\,]$$

$$= (c + \frac{c^2}{b})\bar{p} + \frac{db - [bd + (d - a)c\,]}{b}$$

$$= (\frac{1}{b})[c\,(b + c)\bar{p} - (d - a)c\,] = (\frac{c}{b})[(b + c)\bar{p} - (d - a)]\,.$$

This implies that, given $c > 0$,

$$\frac{d}{d\bar{p}}(L_2(\bar{p}) - G_2(\bar{p})) \begin{cases} > 0, \text{ if } & \bar{p} > p^* \\ = 0, \text{ if } & \bar{p} = p^* \end{cases} . \square$$

(viii) $$\tilde{G}_2(\bar{p}; c, a, b) = -c(1 + \frac{c}{2b})\bar{p}^2 + (\frac{1}{b})[(b+c)\bar{d}(c) - ac]\bar{p}$$

$$+ \left[\frac{(a - \bar{d}(c))^2}{2b}) - (ap^* + \frac{b}{2}p^{*2}) \right]$$

$$= -c(1 + \frac{c}{2b})\bar{p}^2 + (\frac{1}{b})[(b+c)(p^*(b+c) + a) - ac]\bar{p}$$

$$+ \left[(\frac{a}{b})(p^*(b+c) + a) - (\frac{1}{2b})(a^2 + (p^*(b+c) + a)^2) - (ap^* + \frac{b}{2}p^{*2}) \right]$$

$$= -c(1 + \frac{c}{2b})\bar{p}^2 + (\frac{1}{b})[p^*(b+c)^2 + 1(b+c) - ac]\bar{p}$$

$$+ \left[(\frac{a}{b})p^*(b+c) + \frac{a^2}{b} - (\frac{1}{2b})(a^2 + 2ap^*(b+c) + p^*(b+c)^2 - (ap^* + \frac{b}{2}p^{*2}) \right]$$

$$= -c(1 + \frac{c}{2b})\bar{p}^2 + (\frac{1}{b})[p^*(b+c)^2 + ab]\bar{p}$$

$$+ [(\frac{a}{b})p^*(b+c) - (\frac{1}{2b})(2ap^*(b+c) + p^{*2}(b+c)^2) - (ap^* + \frac{b}{2}p^{*2})] .$$

So,

$$\frac{d\tilde{G}_2}{dc} = -(1 + \frac{c}{b})\bar{p}^2 + \left[\frac{2p^*(b+c)}{b} \right] \bar{p} + \left[(\frac{a}{b})p^* - (\frac{1}{2b})(2ap^* + 2p^{*2}(b+c)) \right]$$

$$= -(1 + \frac{c}{b})\bar{p}^2 + \left[\frac{2p^*(b+c)}{b} \right] \bar{p} - (\frac{a}{b})p^* - (\frac{p^*}{b})[p^*(b+c) + a]$$

$$= -(1 + \frac{c}{b})\bar{p}^2 + \left[\frac{2p^*(b+c)}{b} \right] \bar{p} - (\frac{1}{b})p^{*2}(b+c)$$

$$= -(1 + \frac{c}{b})\bar{p}^2 + \left[\frac{p^*(b+c)}{b} \right] (2\bar{p} - p^*)$$

$$= (\frac{1}{b})\left[-(b+c)\bar{p}^2 + p^*(b+c)(2\bar{p} - p^*) \right] = -\left[\frac{b+c}{b} \right] [\bar{p}^2 - 2\bar{p}p^* + p^{*2}]$$

$$= -\left[\frac{b+c}{b}\right](\bar{p} - p^*)^2 < 0\,.$$

Note that property (vii) implies that a legislator will always prefer $\tilde{p}$ to $\tilde{p}\,'$ (where $\tilde{p}$ and $\tilde{p}\,'$ are as defined above). That is, since $G_2(\tilde{p}\,, c) = G_2(\tilde{p}\,', c)$, $(L_2(\tilde{p}\,') - G_2(\tilde{p}\,')) > (L_2(\tilde{p}\,) - G_2(\tilde{p}\,))$ and $\delta_c^{j'} > 0$ then,

$$Q_{j,2}(\tilde{p}\,) = M_j \delta_p^j(\bar{G}_2(\tilde{p}\,)) - N_j \delta_c^j(\bar{L}_2(\tilde{p}\,)) > M_j \delta_p^j(\bar{G}_2(\tilde{p}\,')) - N_j \delta_c^j(\bar{L}_2(\tilde{p}\,')) = Q_{j,2}(\tilde{p}\,')\,.$$

Hence, I will restrict attention to the interval $[p^*, \hat{p}\,]$. Given this, the implicit function theorem implies that there exist functions $\hat{p} = \hat{p}(c, d, a, b)$, $p_\mu = p_\mu(c, d)$, $p_u = p_u(c, d, a, b)$, and $\tilde{p} = \tilde{p}\,(\bar{p}; c, d, a, b)$ (where $\tilde{p}\,(\cdot)$ is defined on $[p^*, p_u]$) on some well-defined neighborhood.

The function $\tilde{p}\,(\bar{p}; c, d, a, b)$ can actually be derived from the definition. Recall that this function is defined implicitly by the equation $G_1(\bar{p}) = G_2(\tilde{p}\,)$. Substituting the appropriate expression yields,

$$a\bar{p} + (\frac{b}{2})\bar{p}^2 - (ap^* + \frac{b}{2}p^{*2}) = -c\,(1 + \frac{c}{2b})\tilde{p}^{\,2} + \frac{1}{b}[(b + c)d - ac\,]\tilde{p} + [\frac{(a-d)^2}{2b} - (ap^* + \frac{b}{2}p^{*2})]$$

or equivalently,

$$-c\,(1 + \frac{c}{2b})\tilde{p}^{\,2} + \frac{1}{b}[(b + c)d - ac\,]\tilde{p} + [\frac{(a-d)^2}{2b} - (a\bar{p} + \frac{b}{2}\bar{p}^2)] = 0\,.$$

Let $\beta_1 \equiv (-c\,(1 + \frac{c}{2b}))$, $\beta_2 \equiv (\frac{1}{b}[b + c)d - ac\,])$, and $\beta_3 \equiv [\frac{(a-d)^2}{2b} - (a\bar{p} + \frac{b}{2}\bar{p}^2)]$. Then,

$$\tilde{p}\,(\bar{p}; c, d, a, b) = \frac{-\beta_2 \pm [\beta_2^2 - 4\beta_1\beta_3]^{1/2}}{2\beta_1}\,. \qquad \text{(A.1)}$$

From Lemma 1, $\tilde{p}\,(\bar{p}; c, d, a, b) > 0$ for all $\bar{p} \in [p^*, p_u(c, d, a, b)]$. Hence, $(\beta_2^2 - 4\beta_1\beta_3) \geq 0$. Furthermore, since $\beta_1 < 0$ and $\beta_2 > 0$ then only the first root needs to be considered, i.e.,

$$\tilde{p}\,(\bar{p}; c, d, a, b) = \frac{-\beta_2 + [\beta_2^2 - 4\beta_1\beta_3]^{1/2}}{2\beta_1} < \frac{-\beta_2 - [\beta_2^2 - 4\beta_1\beta_3]^{1/2}}{2\beta_1} = \tilde{p}\,'(\bar{p}; c, d, a, b) \qquad \text{(A.1')}$$

which from above means the legislator will only consider $\tilde{p}\,(\bar{p};c,d,a,b)$. Note that β_1, β_2, and β_3 are functions of $(c,d,a,b,\bar{p})$; since a and b are fixed then each is effectively a function of c, d, and/or $\bar{p}$ — $\beta_1=\beta_1(c)$, $\beta_2=\beta_2(c,d)$, and $\beta_3=\beta_3(d,\bar{p})$.

The denominator of (F.1′) is zero when $c=0$ and so (F.1′) is undefined at $c=0$. To find $\tilde{p}\,(\bar{p};0,d,a,b)$, set $G_2(\tilde{p}\,,0,d,a,b)$ equal to $G_1(\bar{p};a,b)$. This yields

$$d\tilde{p}\;+[\frac{(a-d)^2}{2b}-(a\bar{p}+\frac{b}{2}\bar{p}^2)]=0$$

which implies

$$\tilde{p}\,(\bar{p};0,d,a,b)=(\frac{1}{d})[a\bar{p}+\frac{b}{2}\bar{p}^2+\frac{(a-d)^2}{2b}]\,. \tag{A.2}$$

Note that $\tilde{p}\,(\bar{p};0,d,a,b)$ is unique. This follows from the fact that $G_2(\bar{p};0,d,a,b)$ is linear in $\bar{p}$ — $G_2(\bar{p};0,d,a,b)=d\bar{p}+[\frac{(a-d)^2}{2b}-(ap^*+\frac{b}{2}p^{*2})]$. Notice, too, that for $d=\bar{d}(c)\equiv p^*(b+c)+a$,

$$\tilde{p}\,(\bar{p};c,\bar{d}(c),a,b)\Big|_{c=0}\;=\;\frac{1}{(p^*b+a)}\left[a\bar{p}+\frac{b}{2}\bar{p}^2+\frac{b}{2}p^{*2}\right]\,. \tag{A.2′}$$

To simplify notation, I will let $\bar{\tilde{p}}\,(\bar{p};c,a,b)\equiv\tilde{p}\,(\bar{p};c,\bar{d}(c),a,b)$. From here on I will restrict my attention to the function $\bar{\tilde{p}}\,(\bar{p};c,a,b)$.

I will now prove that $\bar{\tilde{p}}\,(\bar{p};c,a,b)$ converges pointwise to $\bar{\tilde{p}}\,(\bar{p};0,a,b)$ as c goes to zero. Consider the following problem: find x^* such that $\beta_1x^2+\beta_2x+\beta_3=0$. If $\beta_1\neq0$ there will be two solutions,

$$x_1^*=\frac{-\beta_2+[\beta_2^2-4\beta_1\beta_3]^{1/2}}{2\beta_1}\quad\text{and}\quad x_2^*=\frac{-\beta_2-[\beta_2^2-4\beta_1\beta_3]}{2\beta_1}\,.$$

If $\beta_1=0$ then obviously $x^*=-(\beta_3/\beta_2)$. The next lemma establishes conditions under which x_1^* and x_2^* converge to x^* as β_1 approaches zero; Corollary 1 follows from this lemma.

LEMMA 2:

$$\lim_{\beta_1 \to 0} x_1^* = \begin{cases} x^*, & \text{if } \beta_2 > 0 \\ \infty+, & \text{if } \beta_2 < 0 \end{cases}$$

$$\lim_{\beta_1 \to 0} x_2^* = \begin{cases} -\infty, & \text{if } \beta_2 > 0 \\ x^*, & \text{if } \beta_2 < 0 \end{cases}$$

Proof:

Case (i): $\beta_2 > 0$

$$\lim_{\beta_1 \to 0} x_1^* = \lim_{\beta_1 \to 0} \frac{\frac{1}{2}(\beta_2^2 - 4\beta_1\beta_3)^{-1/2}(-4\beta_3)}{2} \quad \text{by L'Hopital's rule.}$$

So, $\lim_{\beta_1 \to 0} x_1^* = -\beta_3(\beta_2^2)^{-1/2} = x^*$. Obviously, $\lim_{\beta_1 \to 0} x_2^* = -\infty$.

Case (ii): $\beta_2 < 0$

$$\lim_{\beta_1 \to 0} x_1^* = \lim_{\beta_1 \to 0} \frac{-\beta_2 - (\beta_2^2 - 4\beta_1\beta_3)^{1/2}}{2\beta_1} = \infty+$$ and, as above, L'Hopital's rule implies

$\lim_{\beta_1 \to 0} x_2^* = -(\beta_3/\beta_2) = x^*$. □

COROLLARY 1:

Let Q be any compact set in $[p^*, \infty+)$. Then, for any $\bar{p} \in Q$, $\lim_{c \downarrow 0} \bar{\bar{p}}(\bar{p}; c, a, b) = \bar{\bar{p}}(\bar{p}; 0, a, b)$.

Proof:

First note that $\bar{\bar{p}}(\bar{p}; c, a, b) = \dfrac{-\beta_2(c, \bar{d}(c)) + [\beta_2(c, \bar{d}(c))^2 - 4\beta_1(c)\beta_3(\bar{d}(c), \bar{p})]^{1/2}}{2\beta_1(c)}$. Let

$P(\beta_1(c), \beta_2(c, \bar{d}(c)), \beta_3(\bar{d}(c), \bar{p}) \equiv \bar{\bar{p}}(\bar{p}; c, a, b)$. Now $\bar{d}$ is continuous in c, β_2 and β_3 are continuous in c and d, and β_1 is continuous in c. Also P is continuous in β_2 and β_3. Since $\beta_2 > 0$ for all $c \geq 0$ then from Lemma 2, P is also continuous in β_1. Consequently,

$$\lim_{c \downarrow 0} P(\beta_1(c), \beta_2(c, \bar{d}(c)), \beta_3(\bar{d}(c), \bar{p})) = P(\lim_{c \downarrow 0} \beta_1(c), \lim_{c \downarrow 0} \beta_2(c, \bar{d}(c)), \lim_{c \downarrow 0} \beta_3(\bar{d}(c), \bar{p}))$$

$$= \lim_{\substack{\beta_1 \to \beta_1(0)=0 \\ \beta_2 \to \beta_2(0,\bar{d}(0)) \\ \beta_3 \to \beta_3(\bar{d}(0),\bar{p})}} P(\beta_1, \beta_2, \beta_3) = \frac{-\beta_3(\bar{d}(0))}{\beta_2(0,\bar{d}(0))} = \frac{1}{\bar{d}(0)}\,[a\bar{p} + \frac{b}{2}\bar{p}^2 + \frac{b}{2}p^{*2}] = \bar{\bar{p}}(\bar{p}; 0, a, b)\,. \quad \square$$

For succinctness, we will denote $\bar{\bar{p}}(\bar{p}; 0, a, b)$ by $\bar{\bar{p}}_{\lim}(\bar{p})$. Some properties of $\bar{\bar{p}}_{\lim}(\bar{p})$ are proved in Lemma 3.

LEMMA 3:

$\bar{\bar{p}}_{\lim}(\bar{p})$ satisfies the following conditions:

(i) $\bar{\bar{p}}(\bar{p}; c, a, b) > \bar{\bar{p}}_{\lim}(\bar{p})$ if $\bar{p} > p^*$ and $c > 0$,

(ii) $\bar{p} < \bar{\bar{p}}_{\lim}(\bar{p})$ if $\bar{p} > p^*$, and

(iii) $\bar{\bar{p}}(p^*; c, a, b) = \bar{\bar{p}}_{\lim}(p^*) = p^*$.

Proof:

(i) Recall that $G_2(\bar{p}; c, \bar{d}(c), a, b) \equiv \tilde{G}_2(\bar{p}; c, a, b)$ and that $[G_1(\bar{p}; a, b) - \tilde{G}_2(\bar{\bar{p}}(\bar{p}; c, a, b); c, a, b)] = 0$. From Lemma 3(ii), $\bar{\bar{p}}(\bar{p}; c, a, b) \in [p^*, \hat{p}(c, \bar{d}(c), a, b)]$. Since $\tilde{G}_2' \equiv (d\tilde{G}_2/dp) > 0$ on $(p^*, \hat{p}(c, \bar{d}(c), a, b))$ then, by the implicit function theorem, there exists a function $\bar{\bar{p}}(\bar{p}; c, \bar{d}(c), a, b) \equiv \bar{\bar{p}}(\bar{p}; c, a, b)$ such that $[G_1(\bar{p}; a, b) - \tilde{G}_2(\bar{\bar{p}}(\bar{p}; c, a, b); c, a, b)] = 0$ in some neighborhood of $(\bar{p}, c, a, b)$. Moreover, in this neighborhood,

$$\frac{\partial \bar{\bar{p}}}{\partial c} = -\frac{(\partial \tilde{G}_2/\partial c)}{(\partial \tilde{G}_2/\partial \bar{\bar{p}})}\,.$$

From Lemma 1(iii), $(\partial \tilde{G}_2/\partial \bar{\bar{p}}) > 0$. Now, it can be shown that $(\partial \tilde{G}_2/\partial c) < 0$ so that $(\partial \bar{\bar{p}}/\partial c) > 0$. Thus, $\bar{\bar{p}}_{\lim}(\bar{p}) < \bar{\bar{p}}(\bar{p}; c, a, b)$ for any $c > 0$.

(ii) By definition, $G_1(\bar{p}; a, b) = \tilde{G}_2(\bar{\bar{p}}_{\lim}(\bar{p}); 0, a, b)$. From Lemma 1, $G_1 > \tilde{G}_2$ so that $G_1(\bar{p}; a, b) > \tilde{G}_2(\bar{p}; 0, a, b)$. Since $\tilde{G}_2' > 0$ on $(p^*, \hat{p}(c, \bar{d}(c), a, b))$ and

$\bar{p} \in (p^*, \hat{p}(c, \bar{d}(c), a, b))$ then it follows that $\bar{\bar{p}}_{\lim}(\bar{p}) > \bar{p}$ if $\bar{p} > p^*$.

(iii) By definition, $G_1(p^*; a, b) = \tilde{G}_2(p^*; c, a, b)$. Since $G_1(p^*; a, b) = \tilde{G}_2(p^*; c, a, b) = 0$ and $\tilde{G}_2' > 0$ on $(p^*, \hat{p}(c, \bar{d}(c), a, b))$ then $\bar{\bar{p}}(p^*; c, a, b) = p^*$.

Also, $\bar{\bar{p}}_{\lim}(p^*) = \bar{\bar{p}}(p^*; c, a, b)$. □

From above we already know that $\lim_{c \downarrow 0} \tilde{G}_2(\bar{p}; c, a, b) \equiv \tilde{G}_2(\bar{p}; 0, a, b)$ is linear in $\bar{p}$. It can easily be shown that $\lim_{c \downarrow 0} L_2(\bar{p}; c, \bar{d}(c), a, b) \equiv \lim_{c \downarrow 0} \tilde{G}_2(\bar{p}; c, a, b)$[19] so that the former is linear in $\bar{p}$. Both these facts imply that $p_\mu(d, \bar{d}(c))$, $\hat{p}(c, \bar{d}(c), a, b)$, and $p_u(c, \bar{d}(c), a, b)$ become infinitely large as c gets closer to 0 from above—$\lim_{c \downarrow 0} p_\mu = \lim_{c \downarrow 0} \hat{p} = \lim_{c \downarrow 0} p_u = \infty+$.

Now, consider the sequence of functions $\{\bar{\bar{p}}(\bar{p}; \frac{1}{k}, a, b)\}_{k=1}^{\infty+}$. Corollary 1 implies this sequence converges pointwise to $\bar{\bar{p}}_{\lim}(\bar{p})$. It is also true that the sequence converges uniformly to $\bar{\bar{p}}_{\lim}(\bar{p})$ on any compact set $[p^*, p^{**}]$. To show this I will first prove a more generalized case.

LEMMA 4:

Let $F_k : Q \to \mathbf{R}, F : Q \to \mathbf{R}$. Suppose $x_k^* \equiv \underset{Q}{argmax} \, |F_k - F|$ exists and is unique. Then, if $\{F_k\}_{k=1}^{\infty+}$ converges pointwise to F then it converges uniformly to F on Q.

Proof:

For each k, uniqueness of x_k^* implies $|F_k(x) - F(x)| < F_k(x_k^*) - F(x_k^*)|$ for all k and all $x \neq x_k^*$.

Let $M_k \equiv |F_k(x_k^*) - F(x_k^*)|$. Now, by pointwise convergence, $M_{k'} \leq |F_k(x_{k'}^* - F(x_{k'}^*)|$ for all $k' \geq k$. By uniqueness of x_k^*, $|F_k(x_{k'}^*) - F(x_{k'}^*)| < M_k$ for all $k' > k$. Hence, $M_{k'} < M_k$ for all $k > k'$. This means $\{M_k\}_{k=1}^{\infty+}$ is a decreasing sequence. Since $M_k \geq 0$ for all k then M_k

converges to 0 as k increases. Thus, for any $\varepsilon > 0$, $\exists N(\varepsilon)$ such that $M_k < \varepsilon$ if $k \geq N(\varepsilon)$. Since $|F_k(x) - F(x) \leq M_k$ for all k and all $x \in Q$ then it follows that $|F_k(x) - F(x)| < \varepsilon$ for all $x \in Q$ if $k \geq N(\varepsilon)$, i.e., $\{F_k\}_{k=1}^{\infty+}$ converges uniformly on Q. □

COROLLARY 2:

$\{\bar{p}(\bar{p}; \frac{1}{k}, a, b)\}_{k=1}^{\infty+}$ converges uniformly to $\bar{p}_{\lim}(\bar{p})$ on any compact set $[p^*, p^{**}]$.

Proof:

For any fixed k^0 and for any $k \geq k^0$, $\bar{p}(\bar{p}; \frac{1}{k}, a, b)$ is continuous on $[p^*, p_u(\frac{1}{k^0}, \bar{d}(\frac{1}{k^0}), a, b)]$. Now

$$\frac{\partial \bar{p}}{\partial \bar{p}} = \frac{(\frac{1}{2})(\beta_2(c, \bar{d}(c))^2 - 4\beta_1(c)\beta_3(\bar{d}(c), \bar{p}))^{-1/2}(-4\beta_1(c)\frac{\partial \beta_3(\bar{d}(c), \bar{p})}{\partial \bar{p}})}{2\beta_1(c)}$$

$$= -[\beta_2(c, \bar{d}(c))^2 - 4\beta_1(c)\beta_3(\bar{d}(c), \bar{p})]^{-1/2}(-a - b\bar{p})$$

$$= [\beta_2(\bar{d}(c))^2 - 4\beta_1(c)\beta_3(\bar{d}(c), \bar{p})]^{-1/2}(a + b\bar{p}).$$

Hence, $\bar{p}(\bar{p}; \frac{1}{k}, a, b)$ is a positive monotone in $\bar{p}$. Thus, for any compact set $[p^*, p^{**}]$ with $p^{**} \leq p_u(\frac{1}{k^0}, \bar{d}(\frac{1}{k^0}), a, b)$, $\underset{[p^*, p^{**}]}{argmax}\, \bar{p}; \frac{1}{k}, a, b)$ exists and is unique provided $k \geq k^0$. By Corollary 1 and Lemma 4, $\bar{p}(\bar{p}; \frac{1}{k}, a, b)$ converges uniformly to $\bar{p}_{\lim}(\bar{p})$ on $[p^*, p^{**}]$. □

I can now show that, for a given compact set $[p^*, p^{**}]$, $L_1(\bar{p}; c, \bar{d}(c), a, b) > L_2(\bar{p}(\bar{p}; c, a, b); c, \bar{d}(c), a, b)$ for any $\bar{p} \in [p^*, p^{**}]$ if c is sufficiently close to 0. Given the definition of $\bar{p}(\cdot\, ; \cdot)$, this implies conditions (6.9a) and (6.9b) in the main text are satisfied for all $\bar{p} \in [p^*, p^{**}]$ provided c is close to 0.

LEMMA 5:

Let $L_2(\bar{p}; c, \bar{d}(c), a, b) \equiv \tilde{L}_2(\bar{p}; c, a, b)$, $\phi(\bar{p}) \equiv [L_1(\bar{p}; 0, \bar{d}(0), a, b) - \tilde{L}_2(\bar{\bar{p}}(\bar{p}; 0, a, b); 0, a, b)$,

and $\phi_k(\bar{p}) \equiv [L_1(\bar{p}; \frac{1}{k}, \bar{d}(\frac{1}{k}), a, b) - \tilde{L}_2(\bar{\bar{p}}(\bar{p}; \frac{1}{k}, a, b); \frac{1}{k}, a, b)]$. Then, for any $\bar{p} > p^*$,

(i) $\phi(\bar{p}) > 0$ and

(ii) $\{\phi_k(\bar{p})\}_{k=1}^{\infty+}$ converges pointwise to $\phi(\bar{p})$.

Proof:

(i) $\phi(\bar{p}) = b\bar{p}^2 + a\bar{p} + bs(\bar{p} - p^*) - (p^* b + a)\bar{\bar{p}}(\bar{p}; 0, a, b)$. Hence,

$$\frac{\partial \phi}{\partial \bar{p}} = 2b\bar{p} + a + bs - (p^* b + a)\frac{\partial \bar{\bar{p}}}{\partial \bar{p}}(\bar{p}; 0, a, b) = 2b\bar{p} + a + bs - (a + b\bar{p}) = b(\bar{p} + s) > 0$$

and

$$\frac{\partial^2 \phi}{\partial \bar{p}^2} = b > 0.$$

Thus, ϕ is strictly increasing and strictly convex in $[p^*, \infty+)$. Since $\phi(p^*) = 0$ then $\phi(\bar{p}) > 0$ for all $\bar{p} \in (p^*, \infty+)$.

(ii) $\phi_k(\bar{p}) = (b + \frac{1}{2k})\bar{p}^2 + (a + (b + \frac{1}{k})s)\bar{p} - p^*(b + \frac{1}{k})s +$

$$+ (\frac{1}{2k})\bar{\bar{p}}(\bar{p}; \frac{1}{k}, a, b)^2 - \bar{d}(\frac{1}{k})\bar{\bar{p}}(\bar{p}; \frac{1}{k}, a, b) =$$

$$= b\bar{p}^2 + a\bar{p} + bs(\bar{p} - p^*) + (\frac{1}{2k})(\bar{p}^2 + \bar{\bar{p}}(\bar{p}; \frac{1}{k}, a, b)^2) +$$

$$+ (\frac{s}{k})(\bar{p} - \bar{\bar{p}}(\bar{p}; \frac{1}{k}, a, b)) - \bar{d}(\frac{1}{k})\bar{\bar{p}}(\bar{p}; \frac{1}{k}, a, b).$$

From Corollary 1, $\bar{\bar{p}}(\bar{p}; \frac{1}{k}, a, b)$ converges pointwise to $\bar{\bar{p}}(\bar{p}; 0, a, b)$. Thus,

$$\lim_{k \to \infty+} \phi_k(\bar{p}) = b\bar{p}^2 + a\bar{p} + bs(\bar{p} - p^*) - p^* b + a)\bar{\bar{p}}(\bar{p}; 0, a, b) = \phi(\bar{p}). \quad \square$$

In fact, convergence is uniform on any compact set in $[p^*, \infty+)$. This is the thrust of the following proposition.

PROPOSITION A.1:

Let $p^{**} > p^{*}$. $\{\phi_k\}_{k=1}^{\infty+}$ converges uniformly to ϕ on $[p^*, p^{**}]$.

Proof:

$$\phi_k(\bar{p}) - \phi_m(\bar{p}) = \{(b + \frac{1}{2k})\bar{p}^2 + (\frac{1}{2k})\bar{\bar{p}}(\bar{p};\frac{1}{k}, a, b)^2 + a\bar{p} - \bar{d}(\frac{1}{k})\bar{\bar{p}}(\bar{p};\frac{1}{k}, a, b)\}$$
$$- \{(b + \frac{1}{2m})\bar{p}^2 + (\frac{1}{2m})\bar{\bar{p}}(\bar{p};\frac{1}{m}, a, b)^2 + a\bar{p} - \bar{d}(\frac{1}{m})\bar{\bar{p}}(\bar{p};\frac{1}{m}, a, b)\}$$
$$= \frac{1}{2}(\frac{1}{k} - \frac{1}{m})\bar{p}^2 + (\frac{1}{2k})\bar{\bar{p}}(\bar{p};\frac{1}{k}, a, b)^2 - (\frac{1}{2m})\bar{\bar{p}}(\bar{p};\frac{1}{m}, a, b)) - \bar{d}(\frac{1}{k})\bar{\bar{p}}(\bar{p};\frac{1}{k}, a, b)$$
$$+ \bar{d}(\frac{1}{m}\bar{\bar{p}}(\bar{p};\frac{1}{m}), a, b).$$

Since $\lim_{c\downarrow 0} p_u(c, \bar{d}(c), a, b) = \infty+$ then $\exists\, k^0 > 0$ such that $p^{**} < p_u(\frac{1}{k^0}, \bar{d}(\frac{1}{k^0}, a, b)$;

furthermore, from Lemma 3, for any $k, m \geq k^0$, $\bar{\bar{p}}(\bar{p};\frac{1}{k}, a, b), \bar{\bar{p}}(\bar{p};\frac{1}{m}, a, b)$ must be less

than $\bar{\bar{p}}(\bar{p};\frac{1}{k^0}, a, b)$. Thus,

$$|\phi_k(\bar{p}) - \phi_m(\bar{p})| \leq \frac{1}{2}|(\frac{1}{k} - \frac{1}{m})\bar{p}^2| + (\frac{1}{2k})|\bar{\bar{p}}(\bar{p};\frac{1}{k}, a, b)^2| + (\frac{1}{2m})|\bar{\bar{p}}(\bar{p};\frac{1}{m}, a, b)^2|$$
$$+ |\bar{d}(\frac{1}{m})\bar{\bar{p}}(\bar{p};\frac{1}{m}, a, b) - \bar{d}(\frac{1}{k})\bar{\bar{p}}(\bar{p};\frac{1}{k}, a, b)| \leq \frac{1}{2}|\frac{1}{k} - \frac{1}{m}|p_u(\frac{1}{k^0}, \bar{d}(\frac{1}{k^0}), a, b)^2$$
$$+ (\frac{1}{2k})\bar{\bar{p}}(\bar{p};\frac{1}{k^0}, a, b)^2 + (\frac{1}{2m})\bar{\bar{p}}(\bar{p};\frac{1}{m^0}, a, b)^2 + |\bar{d}(\frac{1}{m})\bar{\bar{p}};\frac{1}{m}, a, b) - \bar{d}(\frac{1}{m})\bar{\bar{p}}_{\lim}(\bar{p})$$
$$+ \bar{d}(\frac{1}{m})\bar{\bar{p}}_{\lim}(\bar{p}) - \bar{d}(\frac{1}{k})\bar{\bar{p}}(\bar{p};\frac{1}{k}, a, b)| \leq \frac{1}{2}|\frac{1}{k} - \frac{1}{m}|p_u(\frac{1}{k^0}, \bar{d}(\frac{1}{k^0}, a, b)^2$$
$$+ \frac{1}{2}(\frac{1}{k} + \frac{1}{m})\bar{\bar{p}}(\bar{p};\frac{1}{k^0}, a, b)^2 + |\bar{d}(\frac{1}{m})(\bar{\bar{p}}(\bar{p};\frac{1}{m}, a, b) - \bar{\bar{p}}_{\lim}(\bar{p})| + |\bar{d}(\frac{1}{m})\bar{\bar{p}}_{\lim}(\bar{p})$$
$$- \bar{d}(\frac{1}{k})\bar{\bar{p}}(\bar{p};\frac{1}{k}, a, b)|.$$

Without loss of generality, assume $m \geq k$. Then,

$$|\phi_k(\bar{p}) - \phi_m(\bar{p})| \leq \frac{1}{2}(\frac{1}{k} - \frac{1}{m})p_u(\frac{1}{k^0}, \bar{d}(\frac{1}{k^0}), a, b)^2 + \frac{1}{2}(\frac{1}{k} + \frac{1}{m})\bar{\bar{p}}(\bar{p};\frac{1}{k^0}, a, b)^2$$
$$+ |\bar{d}(\frac{1}{m})(\bar{\bar{p}}(\bar{p};\frac{1}{m}, a, b) - \bar{\bar{p}}_{\lim}(\bar{p}))| + |\bar{d}(\frac{1}{k})(\bar{\bar{p}}_{\lim}(\bar{p}) - \bar{\bar{p}}(\bar{p};\frac{1}{k}, a, b)|$$

From Lemma 1(vii) we know that $\bar{\bar{p}}(\bar{p};\frac{1}{k^0}, a, b) \leq \hat{p}(\frac{1}{k^0}, \bar{d}(\frac{1}{k^0}), a, b)$ for all

$\bar{p} \in [p^*, p_u(\frac{1}{k^0}), d(\frac{1}{k^0}), a, b)]$. Hence,

$$|\phi_k(\bar{p}) - \phi_m(\bar{p})| \le \frac{1}{2}(\frac{1}{k} - \frac{1}{m})p_u(\frac{1}{k^0}, \bar{d}(\frac{1}{k^0}), a, b)^2 + \frac{1}{2}(\frac{1}{k} + \frac{1}{m})\hat{p}(\frac{1}{k^0}, \bar{d}(\frac{1}{k^0}), a, b)^2$$
$$+ |\bar{d}(\frac{1}{m})(\bar{p}(\bar{p}; \frac{1}{m}, a, b) - \bar{p}_{\lim}(\bar{p})| + |\bar{d}(\frac{1}{k})(\bar{p}_{\lim}(\bar{p}) - \bar{p}(\bar{p}; \frac{1}{k}, a, b))| .$$

Now for any $\varepsilon > 0$, the following are true,

(i) $\exists N_1(\varepsilon)$ such that $\frac{1}{2}(\frac{1}{k} - \frac{1}{m})p_u(\frac{1}{k^0}, \bar{d}(\frac{1}{k^0}), a, b)^2 < \frac{\varepsilon}{4}$ if $m \ge k \ge \max\{k^0, N_1(\varepsilon)\}$

and

(ii) $\exists N_2(\varepsilon)$ such that $\frac{1}{2}(\frac{1}{k} + \frac{1}{m})\hat{p}(\frac{1}{k^0}, \bar{d}(\frac{1}{k^0}, a, b)^2 < \frac{\varepsilon}{4}$ if $k, m \ge \max\{k^0, N_2(\varepsilon)\}$.

Also, from Corollary 2, $\exists N_3(\varepsilon)$ and $N_4(\varepsilon)$ such that

$$|\bar{d}(\frac{1}{m})(\bar{p}(\bar{p}; \frac{1}{m}, a, b) - \bar{p}_{\lim}(\bar{p}))| < \frac{\varepsilon}{4} \quad \forall\ \bar{p} \in [p^*, p^{**}] \ \text{ if } \ k, m \ge \max\{k^0, N_3(\ )\} \text{ and}$$
$$|\bar{d}(\frac{1}{k})(\bar{p}(\bar{p}; \frac{1}{k}, a, b) - \bar{p}_{\lim}(\bar{p}))| < \frac{\varepsilon}{4} \quad \forall\ \bar{p} \in [p^*, p^{**}] \ \text{ if } \ m \ge k \ge \max\{k^0, N_4(\varepsilon)\} .$$

Thus, $\phi_k(\bar{p})$ converges uniformly to some function $g(\bar{p})$. From Lemma 5, $\phi_k(\bar{p})$ converges pointwise to $\phi(\bar{p})$. This means $g(\bar{p}) \equiv \phi(\bar{p})$. □

Proposition A.2 below follows directly from Lemma 5 and Proposition A.1. It establishes that, for k sufficiently large, or equivalently c sufficiently close to 0, $\phi_k(\bar{p})$ is positive on any compact set in $(p^*, p^*]$.

PROPOSITION A.2:

For any $\delta > 0$ with $(p^* + \delta) < p^{**}$, $\exists N_\delta$ such that $\phi_k(\bar{p}) > 0$ for all $\bar{p} \in [p^* + \delta, p^{**}]$ if $k \ge N_\delta$.

Proof:

Pick any $\delta > 0$ such that $(p^* + \delta) < p^{**}$ and choose any $\varepsilon_\delta \in (0, \phi < p^* + \delta))$. From Lemma 5, $\exists N(\varepsilon_\delta, p^* + \delta)$ such that $|\phi_k(p^* + \delta) - \phi(p^* + \delta)| < \varepsilon_\delta$ if $k \ge N(\varepsilon_\delta, p^* + \delta)$. Thus, if $k \ge N(\varepsilon_\delta, p^* + \delta)$, $|\phi_k(p^* + \delta) - \phi(p^* + \delta)| < \phi(p^* + \delta)$. Now choose $k^0 \in (N(\varepsilon_\delta, p^* + \delta), \infty+)$

and set $\bar{\varepsilon} = |\phi_{k^0}(p^* + \delta) - \phi(p^* + \delta)|$. From Proposition 1, $\exists N(\bar{\varepsilon})$ such that

$$|\phi_k(\bar{p}) - \phi(\bar{p})| < \bar{\varepsilon} \text{ for all } \bar{p} \in [p^* + \delta, p^{**}] \text{ if } k \geq N(\bar{\varepsilon}).$$

Hence, if $k \geq \max\{k^0, N(\varepsilon)\}$, then

$$|\phi_k(\bar{p}) - \phi(\bar{p})| < |\phi_{k^0}(p^* + \delta) - \phi(p^* + \delta)| < \phi(p^* + \delta) \text{ for all } \bar{p} \in [p^* + \delta, p^{**}].$$

Since $\phi' > 0$ then $\phi(p^* + \delta) \leq \phi(\bar{p})$ for all $\bar{p} \in [p^* + \delta, p^{**}]$. This implies that if $k \geq \max\{k^0, N(\bar{\varepsilon})\}$ then $|\phi_k(\bar{p}) - \phi(\bar{p})| = |\phi(\bar{p}) - \phi_k(\bar{p})| < \phi(\bar{p}) \; \forall \, \bar{p} \in [p^* + \delta, p^{**}]$. But this means $\phi_k(\bar{p}) > 0$ for all $\bar{p} \in [p^* + \delta, p^{**}]$ and all $k \geq \max\{k^0, N(\bar{\varepsilon})\}$. So set $N_\delta = \max\{k^0, N(\bar{\varepsilon})\}$. □

So far I have focused on the properties of the loss and gain functions associated with the two instruments. I will now relate them to the legislator's objective function. We will make two assumptions. First, for any vector (a, b, c, d, s) and for each i, there is some support level $p_{i,j}^0(c, \bar{d}(c), a, b, s) \in [p^*, \infty+)$ such that $Q_{j,i}'(p_{i,j}^0(c, \bar{d}(c), a, b, s); a, b, c, d, s) < 0$. And second, for given (a, b), there exist numbers $\bar{c}, \bar{s} \in (0, \infty+)$ such that $Q_{j,1}'(p^*; a, b, c, \bar{d}(c), s) > 0$ for all $c \in [0, \bar{c}]$ and $s \in [0, \bar{s}]$.[20]

LEMMA 6:

Let $\hat{p}_j^i(c, \bar{d}(c), a, b, s) \equiv \underset{[p^*, \infty+)}{argmax}\, Q_{j,i}(\bar{p}; a, b, c, \bar{d}(c), s)$. Then, $\hat{p}_j^i(c, \bar{d}(c), a, b, s) < \infty+$, $i = 1, 2$.

Furthermore, if $\hat{p}_j^1(c, \bar{d}(c), a, b, s) > p^*$ then $\left[\dfrac{\partial \hat{p}_j^1}{\partial c}\right] < 0$.

Proof:

Since $Q_{j,i}(p^*; a, b, c, \bar{d}(c), s) = 0$, $Q_{j,i}'(p_{i,j}^0(c, \bar{d}(c), a, b, s); a, b, c, \bar{d}(c), s)$, and $Q_{j,i}''(\bar{p}; a, b, c, \bar{d}(c), s) < 0$ for all $\bar{p} \geq p^*$ then $\hat{p}_j^i(c, \bar{d}(c), a, b, s)$ exists and is greater than or equal to p^*.

Now consider $Q_{j,1}(\bar{p}, c, \bar{d}(c), a, b, s) = M_j \delta_p^j(\bar{G}(\bar{p}; a, b) - N_j \delta_c^j(\bar{L}_1(\bar{p}; c, \bar{d}(c), a, b, s))$ where

$\bar{G}_1 \equiv (\frac{1}{M})G_1$ and $\bar{L}_1 = (\frac{1}{N})L_1$. Suppose $\hat{p}_j^1(c, \bar{d}(c), a, b, s) \in (p^*, \infty+)$ then, by the implicit function theorem,

$$Q_{j,1}'(\hat{p}_j^1(c, \bar{d}(c), a, b, s); a, b, c, \bar{d}(c), s) = M_j \delta_p^{j\prime} \cdot \bar{G}_1'(\hat{p}_j^1(c, \bar{d}(c), a, b, s); a, b)$$
$$- N_j \delta_c^{j\prime} \cdot \bar{L}_1'(\hat{p}_j^1(c, \bar{d}(c), a, b, s); c, \bar{d}(c), a, b, s) = 0$$

and

$$\frac{\partial}{\partial c}\hat{p}_j^1(c, \bar{d}(c), a, b, s) = -\frac{(\partial Q_{j,1}'/\partial c)}{Q_{j,1}''}.$$

Since $Q_{j,1}'' < 0$ then $sign(\partial \hat{p}_j^1/\partial c) = sign(\partial Q_{j,1}'/\partial c)$. Now,

$$\frac{\partial Q_{j,1}'}{\partial c} = \frac{\partial}{\partial c}(M_j \delta_p^{j\prime} \bar{G}_1') - N_j[\delta_c^{j\prime} \frac{\partial}{\partial c}\bar{L}_1']$$
$$= -N_j[\delta_c^{j\prime}\frac{\partial \bar{L}_i}{\partial c} + \delta_c^{j\prime\prime} \cdot \frac{\partial \bar{L}_1}{\partial c} \cdot \bar{L}_1'].$$

Furthermore, from above, $\frac{\partial}{\partial c}\bar{L}_1(\cdot, c, \bar{d}(c), a, b, s) \geq 0$ for all $\bar{p} \geq p^*$ and also

$$\frac{\partial}{\partial c}\bar{L}_1'(\cdot, c, \bar{d}(c), a, b, s) = \frac{\partial}{\partial c}[2(b + \frac{c}{2})\bar{p} + (a + (b + c)s)] = (\bar{p} + s) > 0 \quad \text{for all } \bar{p} \geq p^*.$$

Since $(\partial \bar{L}_i/\partial c) > 0$ and $\delta_c^{j\prime}, \delta_c^{j\prime\prime} > 0$ then $(\partial Q_{j,1}'/\partial c) < 0$. □

This lemma in effect states that $\hat{p}_j^1(c, \bar{d}(c), a, b, s) \leq \hat{p}_j^1(0, \bar{d}(0), a, b, s)$ for all $c \geq 0$. For succinctness let $\hat{p}_j^1(0) \equiv \hat{p}_j^1(0, \bar{d}(0), a, b, s)$.

LEMMA 7:

For any $\delta > 0$, $\exists$ a $\hat{c} > 0$ such that $p_u(\hat{c}, \bar{d}(\hat{c}), a, b, s) > (\hat{p}_j^1(0) + \delta)$.

Proof:

This follows from the fact that $\lim_{c \downarrow 0} p_u(c, \bar{d}(c), a, b, s) = \infty+$. □

LEMMA 8:

For any $s \in [0, \bar{s}]$ and $\delta^{**} > 0, \exists\, c^* \in (0, \bar{c}]$ and $\delta^* > 0$ such that

$\hat{p}_j^1(c^*, \bar{d}(c^*), a, b, s) \in (p^* + \delta^*, \hat{p}_j^1(0) + \delta^{**})$, and $\phi_{c^*}(\bar{p}) > 0$ for all $\bar{p} \in [p^* + \delta^*, \hat{p}_j^1(0) + \delta^{**}]$.

Proof:

Pick any $s^0 \in [0, \bar{s}]$ and then choose any $c^0 \in (0, \bar{c}]$. By assumption, $Q'_{1,j}(p^*; c^0, \bar{d}(c^0), a, b, s^0) > 0$ and so $\hat{p}_j^1(c^0, \bar{d}(c^0), a, b, s^0) > p^*$. Thus, $\exists$ some $\delta^* > 0$ such that $(p^* + \delta^*) < \hat{p}_j^1(c^0, \bar{d}(c^0), a, b, s^0)$. Choose any $\delta^{**} > 0$ and form the interval $[p^* + \delta^*, \hat{p}_j^1(0) + \delta^{**}]$. From Proposition F.2 we know that $\exists\, \hat{k} > 0$ such that $\phi_{\hat{k}}(\bar{p}) > 0$ $\forall\ \bar{p} \in [p^* + \delta^*, \hat{p}^1(0) + \delta^{**}]$; let $\hat{c} \equiv (1/\hat{k})$. From Lemma 7 we also know that $\exists\, \hat{c} > 0$ such that $p_u(\hat{c}, \bar{d}(\hat{c}), a, b) > (p_j^1(0) + \delta^{**})$ and from Lemma 6 that, for all $j \in c$, $(\partial\hat{p}_j^1/\partial c) < 0$ or equivalently that $\hat{p}_j^1(c, \bar{d}(c), a, b, s^0) < \hat{p}_j^1(0, \bar{d}(0), a, b, s^0)$ for all $c > 0$. Now,

$$\frac{\partial}{\partial s}\hat{p}_j^1(c, \bar{d}(c), a, b, s) = -\frac{(\partial Q'_{j,1}/\partial s)}{Q''_{j,1}}$$

so that $sign(\partial\hat{p}_j^1/\partial s) = sign(\partial Q'_{j,1}/\partial s)$. Now,

$$\frac{\partial Q'_{j,1}}{\partial s} = \frac{\partial}{\partial s}M_j\delta_p^{j\prime}\bar{G}'_1 - \frac{\partial}{\partial s}N_j\delta_c^{j\prime}\bar{L}'_1 = -N_j[\delta_c^{j\prime}\frac{\partial\bar{L}'_1}{\partial s} + \delta_c^{j\prime\prime}(\frac{\partial\bar{L}_1}{\partial s}\bar{L}'_1].$$

Since $(\partial\bar{L}'_1/\partial s) = (1/N)(b + c)$ and $(\partial\bar{L}_1/\partial s) = (1/N)(h(\bar{p}) - f(\bar{p}))$ then $(\partial Q'_{j,1}/\partial s) < 0$. Consequently, $\hat{p}_j^1(0, \bar{d}(0), a, b, s^0) < \hat{p}_j^1(0, \bar{d}(0), a, b, 0) \le \hat{p}^1(0) + \delta^{**}$. Hence, $\hat{p}_j^1(c^0, \bar{d}(c^0), a, b, s^0)$, $\hat{p}_j^1(\hat{c}, \bar{d}(\hat{c}), a, b, s^0)$ and $\hat{p}_j^1(\hat{c}, \bar{d}(\hat{c}), a, b, s^0)$ must be less than $(\hat{p}^1(0) + \delta^{**})$. Finally set $c^* = \min\{c^0, \hat{c}, c^*\}$ then, $\hat{p}_j^1(c^*, \bar{d}(c^*), a, b, s^0) \in (p^* + \delta^*, p^1(0) + \delta^{**})$ and, since $(\hat{p}^1(0) + \delta^{**}) < p_u(c^*, \bar{d}(c^*), a, b, s^0)$, $\phi_{c^*}(\bar{p}) > 0$ for all $\bar{p} \in [p^* + \delta^*, \hat{p}^1(0) + \delta^{**}]$. Note also that $c^* \in (0, \bar{c}]$ since $c^0 \in (0, \bar{c}]$. □

Proposition A.2 and Lemma 8 prove Proposition 6.2 in the text. The last proposition states that

$\Delta_{1,2} < 0$ given Proposition A.2 and Lemma 8.

PROPOSITION A.3:

For any $c \in [0, c^*]$ (where c^* is defined as in Lemma 8) and for any $s \in (0, \bar{s}]$,

$$Q_{j,2}(\hat{p}_j^2(c, \bar{d}(c), a, b); c, \bar{d}(c), a, b) > Q_{j,1}(\hat{p}_j^1(c, \bar{d}(c), a, b, s); c, \bar{d}(c), a, b, s).$$

Proof:

Lemma 8 implies that for all $c \in [0, c^*]$,

$Q_{j,2}(\bar{\bar{p}}(\hat{p}_j^1(c, \bar{d}(c), a, b); c, \bar{d}(c), a, b) > Q_{j,1}(\hat{p}_j^1(c, \bar{d}(c), a, b, s); c, \bar{d}(c), a, b, s)$. But

$Q_{j,2}(\hat{p}_j^2(c, \bar{d}(c), a, b); c, \bar{d}(c), a, b) \geq Q_{j,2}(\bar{\bar{p}}(\hat{p}_j^1(c, \bar{d}(c), a, b); c, \bar{d}(c), a, b)$. □

What this proposition says is that the legislator will always choose a production quota over a price floor provided demand is sufficiently inelastic at the equilibrium.

CHAPTER 7

AN EMPIRICAL ANALYSIS OF INSTRUMENT CHOICE IN U.S. AGRICULTURE: 1953-72

In this chapter, I will present some statistical evidence supportive of predictions made in chapter six about the nature of price support programs for selected agricultural commodities. I will investigate the markets for eight commodities, namely, wheat, corn grain sorghum, barley, oats, cotton, tobacco, and rice. These commodities were heavily supported over the twenty-year period, 1953-72; in fact, wheat, corn, and cotton were the most controversial.

As I hinted earlier, the character of regulation of major agricultural commodities changed over time and varied across markets. In fact, as I will illustrate shortly, the variation was considerable. One therefore cannot help but think that perhaps some underlying choice process other than a naive economic efficiency mechanism is involved. My objective here is to show that the facts are statistically consistent with my proposed instrument choice model.

In the first part of the chapter, I describe the basic instruments that were used to support prices during the twenty-year period. In the second section, I then show how these were combined to form mixed instruments; agricultural price supports have almost always been implemented via some type of mixed instrument. I also illustrate how each commodity was regulated over the period, i.e., what instrument was used for a particular commodity in a given year, and then explain the workings of each mixed instrument. In the third section, I state the hypotheses to be tested and relate them to predictions of my instrument choice model. I discuss how the hypotheses proceed from the comparative statics results in chapter six. Finally, in the last section, I present and analyze the econometric results. I first explain in brief the probabilistic model used to to test the hypotheses and then produce the estimates of the coefficients of this model. I end with an analysis of the estimates.

A. The Basic Instruments:

Between 1953 and 1972, there were five basic methods used to support prices: a price floor, acreage allotments, marketing quotas, an acreage diversion program, and income payments. There were three kinds of diversion programs—the Soil Bank, the Acreage

Retirement program, and the Set Aside program. Acreage allotments and diversion programs represent different methods by which production of a commodity could be controlled.

As explained earlier, a price floor is a price set above the free market level by the government. To keep the price from falling, the government agrees to buy the commodity at the price floor. Hence, if the market price is above the floor, farmers sell in the market; if it is below, they sell to the government. The government ends up purchasing and storing all of the surplus production. The government attempts to dispose of the surplus without affecting the domestic market, for instance, by giving some of the commodity as aid to a third world country or to the very poor in this country who otherwise would not purchase the commodity. The remainder is eventually allowed to rot.

Acreage allotments are restrictions on the acreage that farmers may plant to a crop. If a crop is subject to allotments, a national allotment is proclaimed which then is allocated to the States and farmers, usually on the basis of past plantings of the crop. In general, to avail of price supports for the crop, a farmer must not exceed his allotment.

Restrictions on the quantities of a crop that may be grown on acreage allotments are referred to as marketing quotas. Whenever marketing quotas for a given crop are proclaimed, farmers producing the crop vote in referendum to approve or disapprove the quotas; a two thirds majority is required for approval. If approved, then besides losing price supports, a farmer was subject to penalties if he exceeded his acreage allotment.

A marketing quota differs from a production quota (as defined in chapter six) in that it is used in conjunction with a price floor. Consequently, it may be nonbinding; that is, the quantity limit may (and usually does) exceed the demand for the commodity at the established price floor. A production quota is in effect a binding marketing quota. Figure 7.1 illustrates the distinction between the two. Under a production quota, quantity is restricted to $\bar{q}$, resulting in a quota equivalent price support of $\bar{p}$; there is no excess production. With a price floor cum

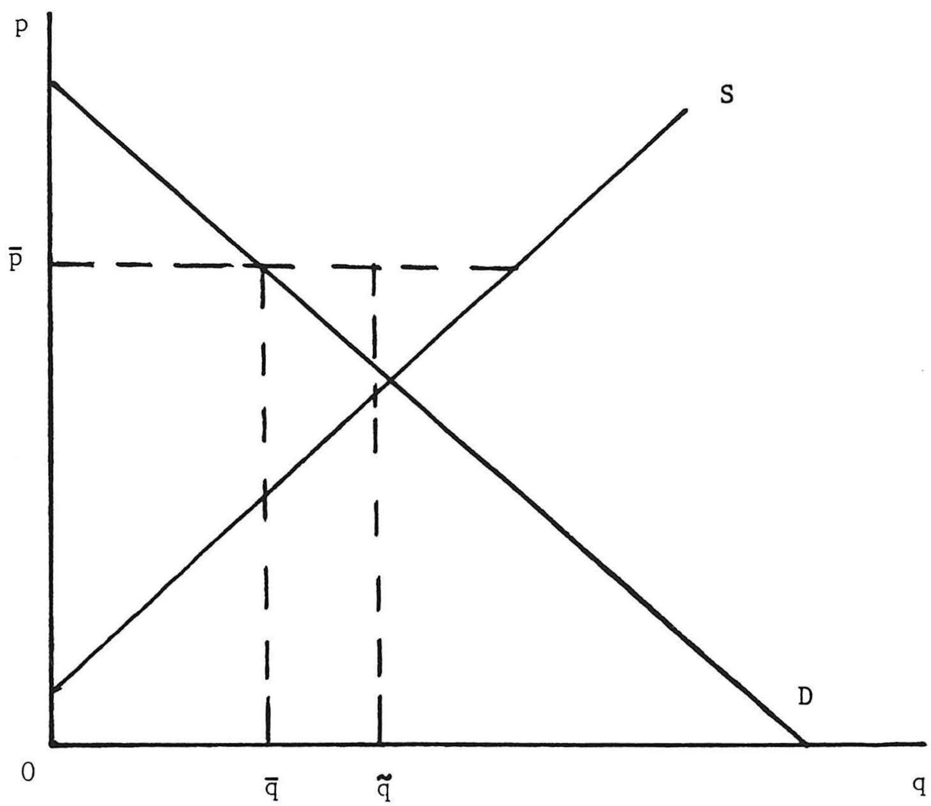


FIGURE 7.1

marketing quota, the floor is set at $\bar{p}$, but the quantity limit may be set above $\bar{q}$, for instance, at $\tilde{q}$; thus a surplus of $\tilde{q} - \bar{q}$ is created.

The closest approximate to a production quota that was implemented was a poundage quota. A poundage quota is a limit on the number of pounds of a crop that a farmer may market. Only tobacco has been subject to such quotas.

Acreage diversion refers to restrictions on acreage planted to a crop over and above acreage allotments. The diversion may be optional or mandatory. For example, a farmer may be restricted by allotments to planting 200 acres to wheat. If the diversion is optional, then he may choose to reduce his acreage further by some x percent of the 200. If it is mandatory, then in order to avail of price supports, he must reduce his acreage by x percent. In either case, the farmer is compensated by the government for the additional reduction.

There were three diversion programs introduced during the twenty-year period. The Soil Bank was first implemented in 1956 and was ended in 1958. The Acreage Retirement Program was introduced by the Kennedy administration in 1961 and continued in operation (in varying degrees) until 1969. It was then replaced by the Set Aside program. The latter differed from the other two in that it was not crop-specific. The Soil Bank and the Acreage Retirement Program were implemented on a crop by crop basis. For example, suppose a farmer has 100 acres allocated to wheat and 200 acres to corn. A farmer would (if he decided to) withdraw 100 times x percent of his wheat acreage and 200 times y percent of his corn acreage. Under the Set Aside program, he would withdraw z percent of his total acreage (300 acres). In other words, the Set Aside was a weaker form of control over production.

The Acreage Retirement Program differed slightly from the Soil Bank. The latter was purely voluntary. If he so wished, a farmer could withdraw the required acreage. The former was mandatory. To avail of price supports, a farmer had to withdraw a minimum number of acres from production. He could, if he wanted, withdraw more.[1] Under either program, a farmer was compensated for the withdrawn land.

Acreage allotments, marketing quotas, and acreage diversion programs represent different degrees of control over the production of one or more crops. Each represents a tilting of the supply curve upward; the more restrictive, the more tilted the curve.

To subsidize farmers, the government can pay farmers directly the difference between the price support and the free market price (assuming the latter is below the former) for each unit he sells. This method of support is called income or direct payments. Under this scheme, the price support is called the target price. Total payments are normally restricted to a maximum, either directly, e.g., no farmer may receive more than $55,000, or indirectly, e.g., a farmer can obtain such payments only up to a maximum of x bushels. To make this scheme operational, the government guarantees to buy the commodity at the free market price (more precisely, an estimate thereof) and in addition pays farmers the differential between the market and the target prices.

An income payments scheme differs subtly from a price floor. Figures 7.2a and 7.2b illustrate this. Both methods result in some excess production, but the excess under the former is smaller—$(\overline{q}_s - q^*)$ as opposed to $(\overline{q}_s - q_{\overline{d}})$. Furthermore, with income payments consumers pay the free market (and thus a lower) price for the commodity—$p_c = p^*$. The loss in consumer surplus due to a higher price is therefore eliminated—the area $(A + B)$ in Figure 7.2b. However, consumers end up paying for the differential between the target price p_T (the same as $\overline{p}$) and the free market price—the area $(A' + B')$ in Figure 7.2a. Notice that the total loss to consumers is smaller under an income payments scheme—$(A' + B' + C' + D' + E' + F')$ is less than $(A + 2B + C + D + E + F + G)$. But the gain to farmers is the same – $(A' + B' + C') = (A + B + C)$; only the manner of payment differs.

In only a few cases was a commodity supported via a basic instrument. Rather, support was provided through some combination of the basic instruments. A combination is called a

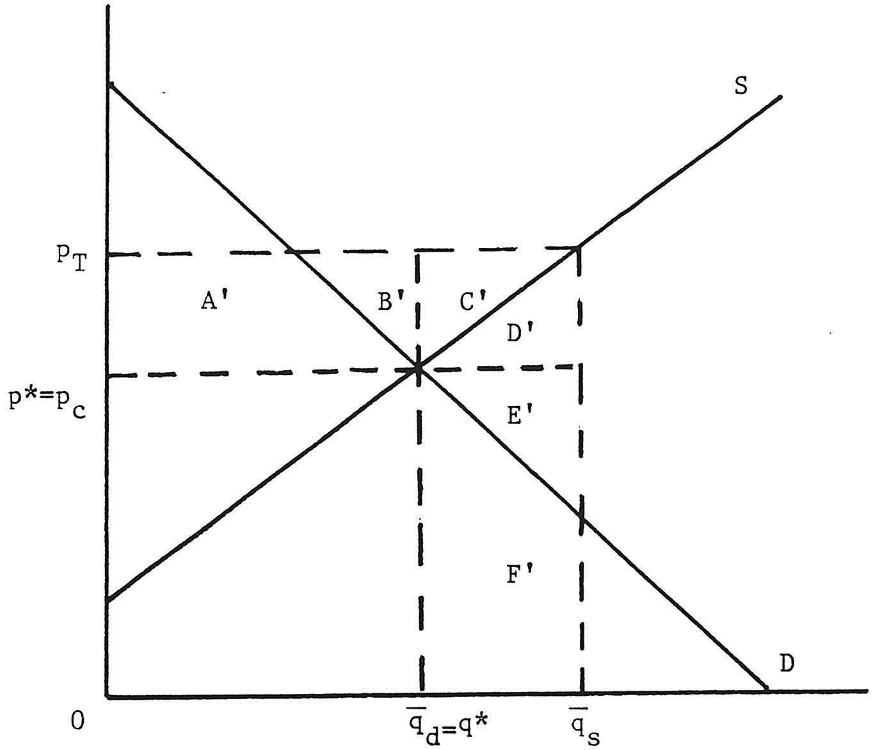


FIGURE 7.2 a

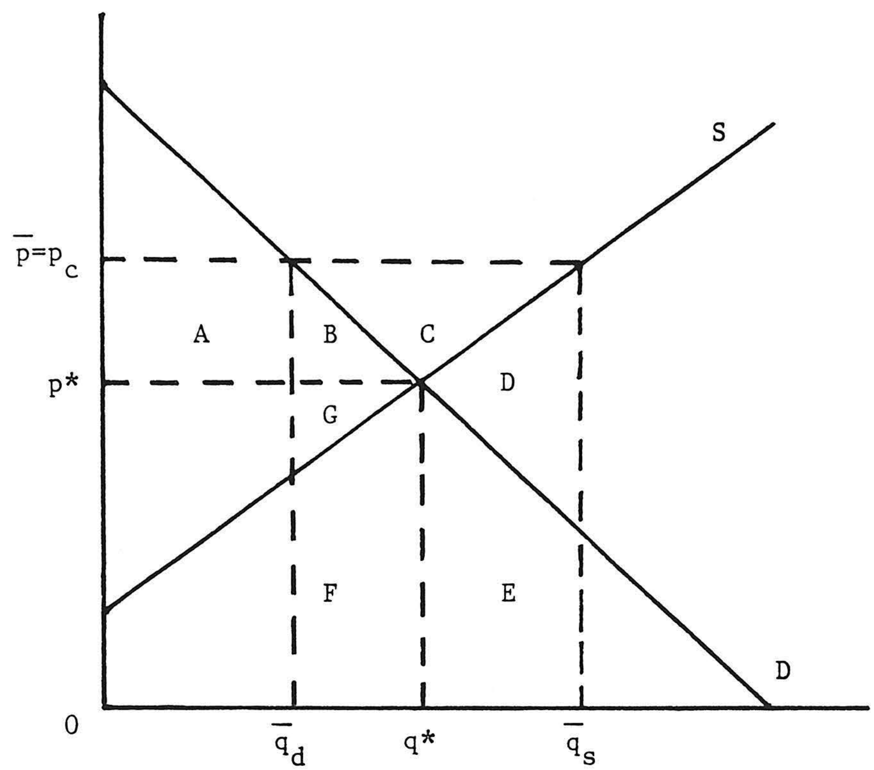


FIGURE 7.2 b

mixed instrument. To facilitate the discussion, I will label the basic instruments in the following way: price floor (1), acreage allotments (2), marketing quota (3), Soil Bank (4), acreage retirement (5), poundage quota (6), set aside (7), and income payments (8). A mixed instrument will be characterized by some combination of numbers, e.g., 1, 2, 4; note that a basic instrument is in effect a degenerate mixed instrument. I now turn to a discussion of the kinds of mixed instruments used during the period 1953-72.

B. The Mixed Instruments

In the previous chapter, I gave a rough idea of how some agricultural commodities were regulated during the twenty-year period. Here I will provide a much more detailed picture. In Table 7.1, I indicate how wheat, corn, grain sorghum, barley, oats, cotton, tobacco, and rice were regulated in each of the twenty years. For example, in 1955, wheat, cotton, tobacco and peanuts were supported via a price floor, acreage allotments, and marketing quotas; corn was supported via a price floor and acreage allotments; and grain sorghum, barley, and oats were supported via a price floor.

Table 7.1 shows clearly the considerable variation in the way prices of the eight commodities were supported. At any given year, the method of support differed across commodities, and for any given commodity, the method changed over time. In Table 7.2, I list all the mixed instruments (both degenerate and nondegenerate) used during the period.

As Table 7.2 shows, the kinds of instruments adopted involved either a price floor or income payments in combination with varying degrees of production control. In Figure 7.3a, I illustrate a price floor with acreage allotments (2); in Figure 7.3b, a price floor with acreage allotments (2) and marketing quotas (3); in Figure 7.3c, a price floor with acreage allotments (2), marketing quotas (3), and the Soil Bank (4); in Figure 7.3d, a price floor with acreage allotments (2) and acreage retirement (5); in Figure7.3e, a price floor with acreage allotments (2), marketing quotas (3), and acreage retirement (5). Each of these cases involves one or more

TABLE 7.1

Year/Commodity	Basic Instruments (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1952:								
Wheat	×							
Corn	×							
Grain Sorghum	×							
Oats	×							
Barley	×							
Cotton	×							
Tobacco	×	×	×					
Rice	×							
1953:								
Wheat	×							
Corn	×							
Grain Sorghum	×							
Oats	×							
Barley	×							
Cotton	×							
Tobacco	×	×	×					
Rice	×							
1954:								
Wheat	×	×	×					
Corn	×	×						
Grain Sorghum	×							
Oats	×							
Barley	×							
Cotton	×	×	×					
Tobacco	×	×	×					
Rice	×							
1955:								
Wheat	×	×	×					
Corn	×	×						
Grain Sorghum	×							
Oats	×							
Barley	×							
Cotton	×	×	×					
Tobacco	×	×	×					
Rice	×	×	×					

1956:				
Wheat	×	×		×
Corn	×	×		×
Grain Sorghum	×			
Oats	×			
Barley	×			
Cotton	×	×	×	×
Tobacco	×	×	×	
Rice	×	×	×	
1957:				
Wheat	×	×		×
Corn	×	×		×
Grain Sorghum	×			
Oats	×			
Barley	×			
Cotton	×	×	×	×
Tobacco	×	×	×	
Rice	×	×	×	
1958:				
Wheat	×	×	×	×
Corn	×	×		×
Grain Sorghum	×			
Oats	×			
Barley	×			
Cotton	×	×	×	×
Tobacco	×	×	×	
Rice	×	×	×	
1959:				
Wheat	×	×	×	
Corn	×			
Grain Sorghum	×			
Oats	×			
Barley	×			
Cotton	×	×		
Tobacco	×	×	×	
Rice	×	×	×	
1960:				
Wheat	×	×	×	
Corn	×			
Grain Sorghum	×			
Oats	×			
Barley	×			
Cotton	×	×		
Tobacco	×	×	×	
Rice	×	×	×	

1961:						
Wheat	×	×	×			
Corn	×	×		×		
Grain Sorghum	×	×		×		
Oats	×					
Barley	×					
Cotton	×	×	×			
Tobacco	×	×	×			
Rice	×	×	×			
1962:						
Wheat	×	×	×	×		
Corn	×	×		×		
Grain Sorghum	×	×		×		
Oats	×					
Barley	×	×		×		
Cotton	×	×	×			
Tobacco	×	×	×			
Rice	×	×	×			
1963:						
Wheat		×	×	×		×
Corn		×		×		×
Grain Sorghum		×		×		×
Oats	×					
Barley		×		×		×
Cotton	×	×	×			
Tobacco	×	×	×			
Rice	×	×	×			
1964:						
Wheat		×		×		×
Corn		×		×		×
Grain Sorghum		×		×		×
Oats	×					
Barley		×		×		×
Cotton	×	×	×			
Tobacco	×	×	×			
Rice	×	×	×			
1965:						
Wheat		×		×		×
Corn		×		×		×
Grain Sorghum		×		×		×
Oats	×	×		×		×
Barley		×		×		×
Cotton	×	×	×			
Tobacco					×	
Rice	×	×	×			

1966:						
Wheat		×		×		×
Corn		×		×		×
Grain Sorghum		×		×		×
Oats	×	×		×		
Barley		×		×		×
Cotton		×	×	×		×
Tobacco					×	
Rice	×	×	×			
1967:						
Wheat		×				×
Corn		×		×		×
Grain Sorghum		×		×		×
Oats	×	×				
Barley	×	×				
Cotton		×	×	×		×
Tobacco					×	
Rice	×	×	×			
1968:						
Wheat		×				×
Corn		×		×		×
Grain Sorghum		×		×		×
Oats	×	×				
Barley	×	×				
Cotton		×	×	×		×
Tobacco					×	
Rice	×	×	×			
1969:						
Wheat		×		×		×
Corn		×		×		×
Grain Sorghum		×		×		×
Oats	×	×				
Barley		×		×		×
Cotton		×	×			×
Tobacco					×	
Rice	×	×	×			
1970:						
Wheat		×		×		×
Corn		×		×		×
Grain Sorghum		×		×		×
Oats	×	×				
Barley		×		×		×
Cotton	×	×	×			
Tobacco					×	
Rice	×	×	×			

1971:								
Wheat							×	×
Corn							×	×
Grain Sorghum							×	×
Oats	×							
Barley							×	×
Cotton							×	×
Tobacco						×		
Rice	×	×	×					
1972:								
Wheat							×	×
Corn							×	×
Grain Sorghum							×	×
Oats	×							
Barley							×	×
Cotton							×	×
Tobacco						×		
Rice	×	×	×					

This data set was constructed from information contained in the *Congressional Quarterly Almanac*, Volumes 8-29, and from Cochrane and Ryan (1978).

TABLE 7.2

(1)	Price floor	
(1,2)	Price floor with:	acreage allotments
(1,2,3)	Price floor with:	acreage allotments marketing quotas
(1,2,3,4)	Price floor with:	acreage allotments marketing quotas Soil Bank
(1,2,5)	Price floor with:	acreage allotments acreage retirement
(1,2,3,5)	Price floor with:	acreage allotments marketing quotas acreage retirement
(6)	Poundage quota	
(8,2)	Income payments with:	acreage allotments
(8,2,5)	Income payments with:	acreage allotments acreage retirement
(8,2,4,5)	Income payments with:	acreage allotments marketing quotas acreage retirement
(8,7)	Income payments with:	set aside

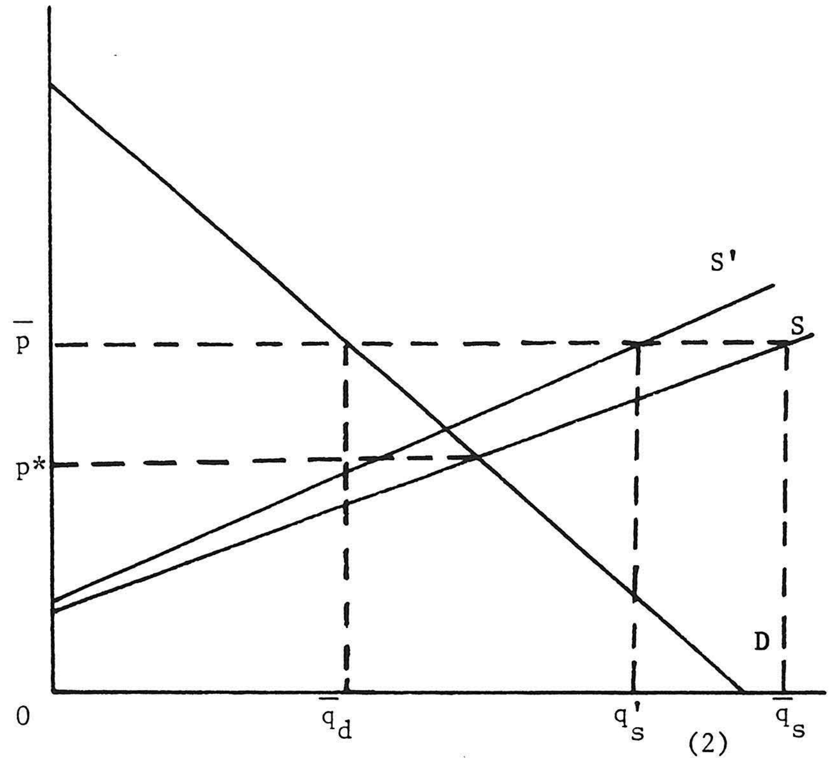


FIGURE 7.3 a

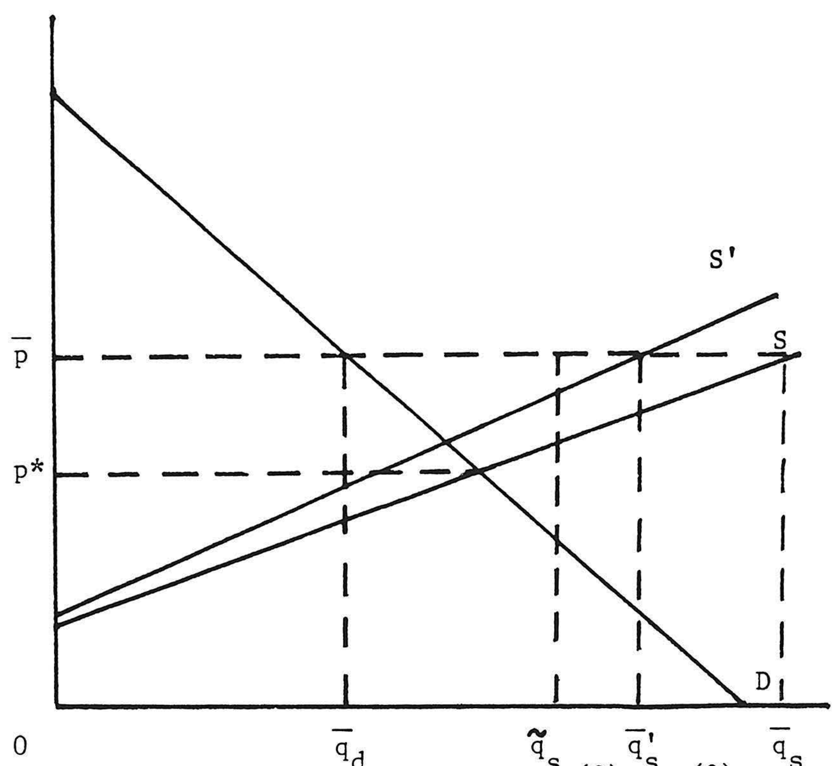


FIGURE 7.3 b

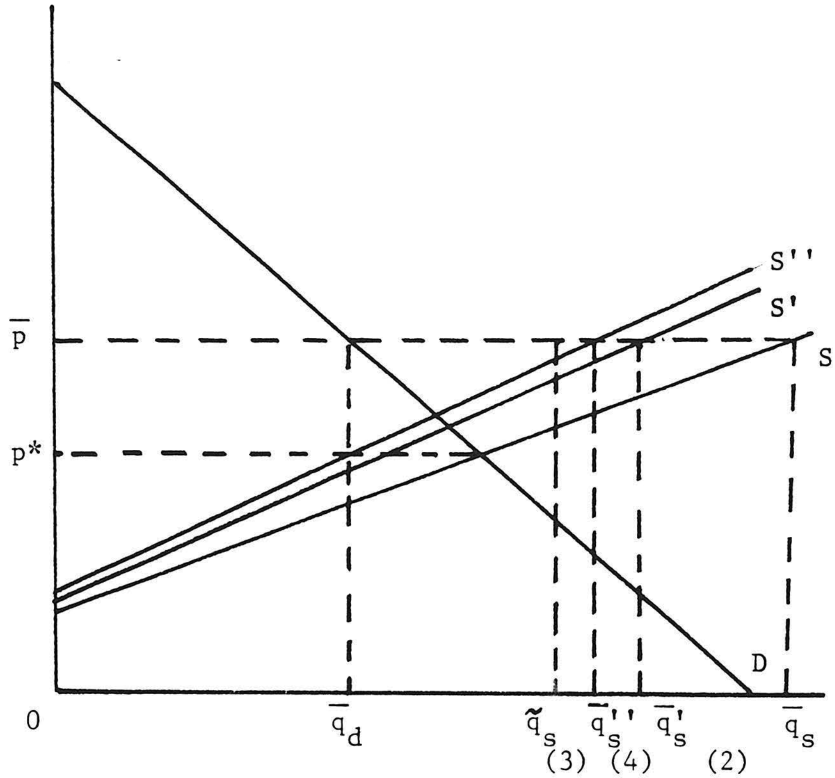


FIGURE 7.3 c

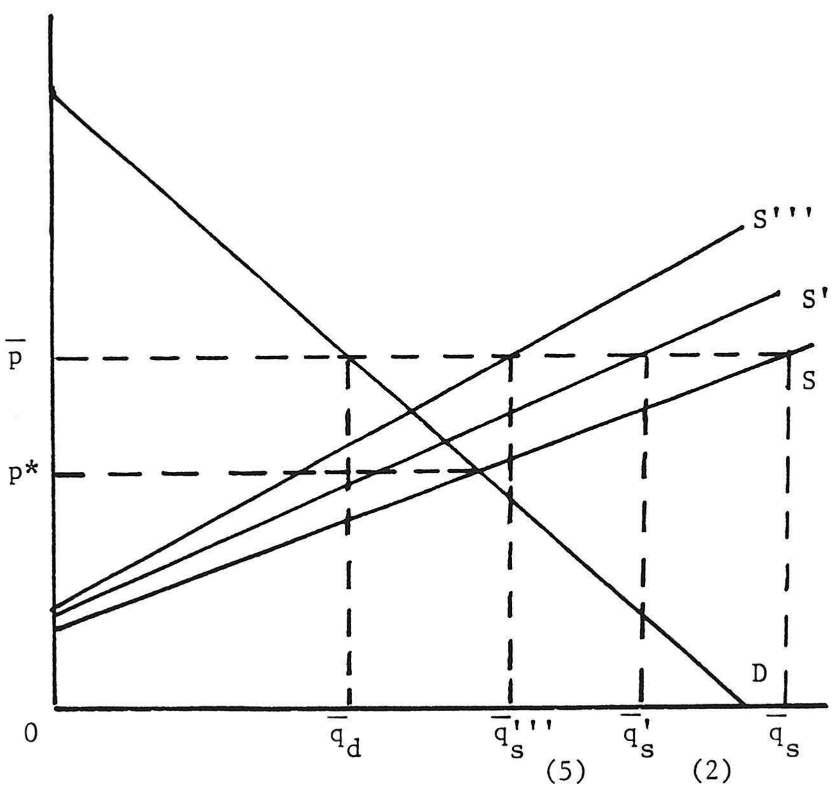


FIGURE 7.3 d

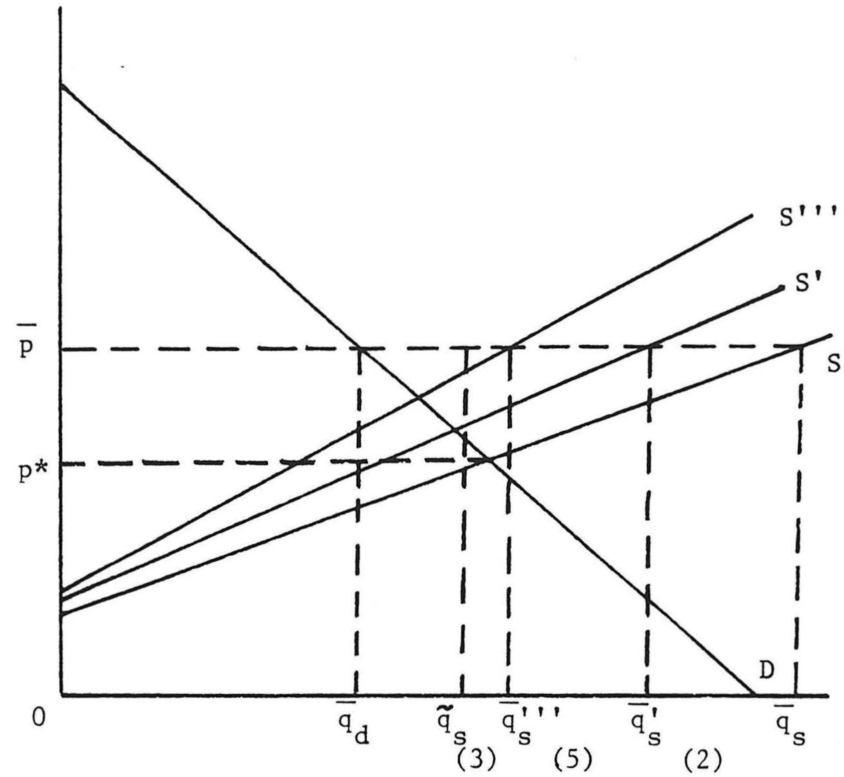


FIGURE 7.3 e

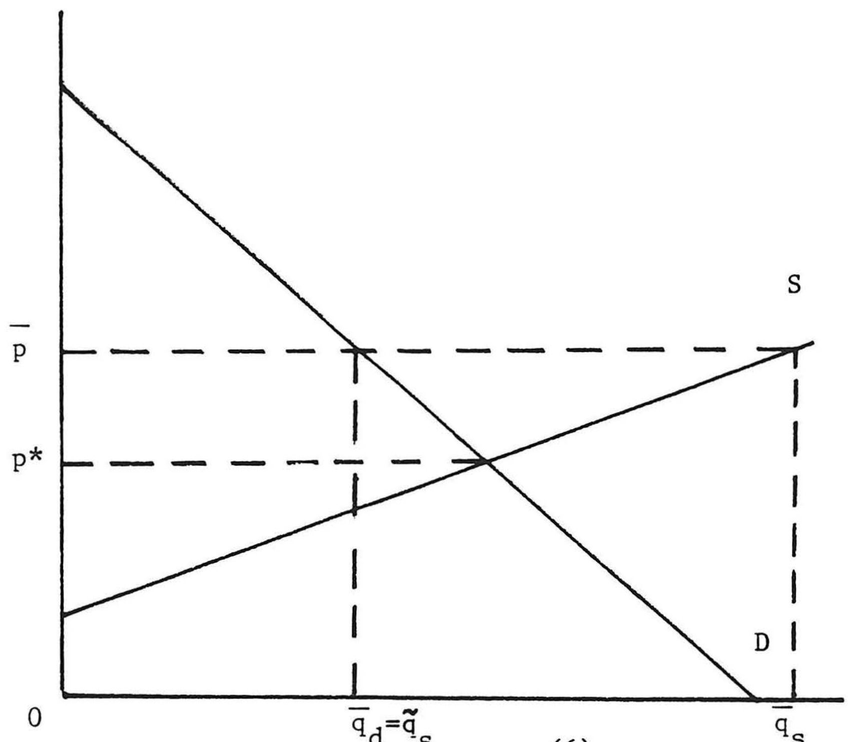


FIGURE 7.3 f

angular shifts in the supply curve upward. Each shift represents the added effect of a production control method. The method that causes a particular shift is indicated between the production levels associated with the shift and the level prior to the shift. Whenever applicable, the effect of a marketing quota (3) is similarly indicated. I also depict a poundage quota (6) in Figure 7.3f; a poundage quota approximates a production quota and so can be interpreted as a binding marketing quota.

Notice that the instruments illustrated in Figures 7.3a through 7.3f all involve a price floor, but more importantly, differ in terms of the degree of control over production. They have been presented sequentially in terms of increasing degree of control. A price floor with acreage allotments is the least restrictive, a price floor with acreage allotments and marketing quotas the next least restrictive, etc.[2] Clearly, these instruments can be classified in ascending order according to their associated degree of production control.

The same can be done for those income payments based instruments. Income payments with acreage allotments, marketing quotas, and acreage retirement are the most restrictive, income payments with acreage allotments and acreage retirement the next most restrictive, income payments with acreage allotments the third most restrictive, and income payments with the set aside the least restrictive.

The acreage retirement programs associated with income payments schemes were in general less restrictive than those associated with a price floor. In any case, they were never more restrictive. For example, if under the former, a farmer were required to withdraw twenty percent of his allotment to a crop, then under the latter he would have been required to withdraw, say, ten to fifteen percent.

In Table 7.3, I classify all the instruments according to their fundamental method of support—whether it is price floor or income payments based—and the degree of production control. The price floor based instruments are ordered in terms of increasing degree of control;

the income payments based instruments are arranged in reverse order. Again, to facilitate the discussion, I have numbered the instruments $M1$ through $M11$; $M1$ through $M7$ are price floor-based while $M8$ through $M11$ are income payments-based.

TABLE 7.3

No.	Price Floor	No.	Income Payments
$M1$	1	$M8$	8,2,3,5
$M2$	1,2	$M9$	8,2,5
$M3$	1,2,3	$M10$	8,2
$M4$	1,2,3,4	$M11$	8,7
$M5$	1,2,5		
$M6$	1,2,3,5		
$M7$	6		

This brief description of the different price support methods adopted during the period sets the stage for an empirical analysis of instrument choice in the aforementioned agricultural markets. The instruments $M1$ through $M11$ can be organized into several classes with each class representing a certain degree of control. For example, $M1$, $M2$, and $M11$ can be classified as weak controls, $M3$, $M4$, and $M9$ as mild controls, and the rest as stringent controls. Numbers can be assigned to the different classes to create a discrete variable. The variable can then be used as a dependent variable in a limited dependent variable regression. A dummy independent variable can be used to account for differences in regimes—whether a price floor or income payments was the fundamental method of support.

The objective of the regression is to test possible implications of predictions of the instrument choice model in chapter six. These implications are discussed in detail in the next section.

C. The Hypotheses:

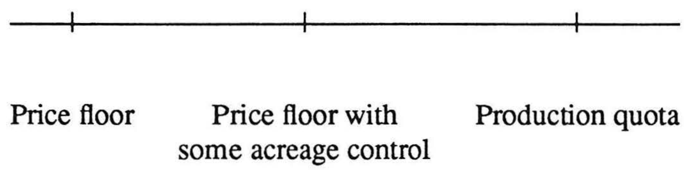
The comparative static results in chapter six suggest certain hypotheses about the choice of price support methods for the eight agricultural commodities. I emphasize that the hypotheses to be tested are suggestions and not predictions. In the theoretical model, the decision-maker is a single legislator. In the econometric model below, I implicitly assume that the appropriate subcommittee makes the choice of instrument, e.g., the wheat subcommittee decides what method to use for wheat. Thus, in effect, I assume that the selected political and economic variables affect the subcommittee's choice in the same way that they affect a single legislator, that there are no serious conflicts between the subcommittees, and that bargaining between the Agricultural Committee and the Chamber is for levels of support or payments (whichever is applicable) only.

The propositions in chapter six deal with the choice of production control method(s) conditional on a price floor. Propositions 6.1 , 6.2, and 6.3 indicate that differences in demand and supply elasticities (at the free market level) affect the choice between a (pure) price floor and a production quota. The more inelastic demand is and/or the more elastic supply is, the more likely it is that the latter will be used to support the price of a commodity. Since elasticities generally do not change much from one year to the next they can be viewed as economic determinants of cross sectional choice: why is commodity X supported via one instrument and commodity Y via another?

Proposition 6.4 indicates that the average cost of maintaining the surplus affects the choice; proposition 6.6 (technological change) indirectly suggests that the magnitude of the surplus also affects the choice. The average cost and the magnitude of the surplus affect both the cross sectional and the temporal choice—shift in instruments over time—of instruments.

A (pure) price floor and a production quota are two extremes. As explained earlier, a production quota is equivalent to a price floor combined with a binding marketing quota and thus is a price floor with the most stringent form of control on production. Proposition 6.6 implies that some intermediate form may be adopted; a price floor with milder production controls such as some reduction in acreage could be acceptable. Hence, one can imagine a spectrum of choices with a price floor on one end, a production quota on the other, and a number of intermediate forms in between. Figure 7.4 illustrates this.

FIGURE 7.4



The choice among production control methods suggested above transfers quite readily to an income payments regime. The conclusions of propositions 6.1, 6.3, and 6.4 still hold if a price floor were replaced by a (pure) income payments scheme, that is, if instead the choice were between an income payments scheme and a production quota.[4] The same is true of proposition 6.2, though not as obvious. As discussed earlier, the gain of producers under either regime is the same; only the manner of payment differs. On the other hand, consumers lose less under the latter. This means that conditions (6.9a) and (6.9b) would certainly be satisfied (see chapter six) so that the conclusion of the proposition would remain valid: if demand were sufficiently inelastic, then a production quota would be chosen by a legislator over an income payments scheme.

The conclusions of propositions 6.5 and 6.6 also follow through. In Figure 7.5, I depict the effect of acreage restrictions under an income payments regime. As with a price floor regime, the gain to producers falls—from $(A+B+C+D+E+F+G+H+I+J)$ to $(A+B+C+H)$. The loss to consumers without the restrictions, L, is indicated by the area $[(A+B+C+D+E+F+G)+p_T(q_s-q^*)]$. With the restrictions, the loss L' is

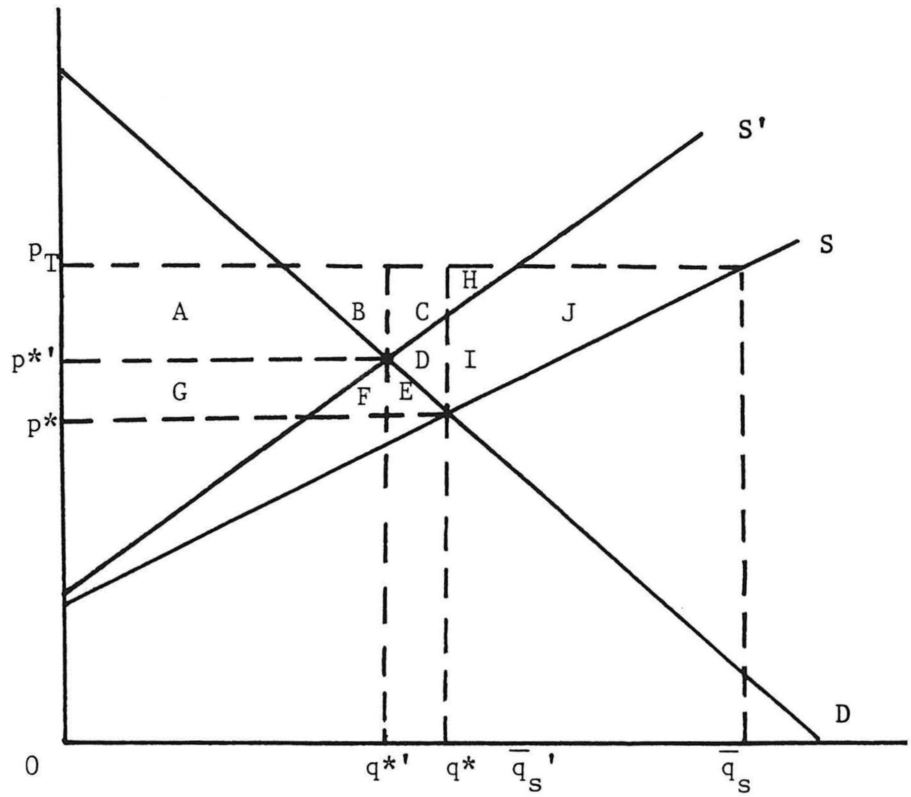


FIGURE 7.5

$[(E + F + G) + \{(A + B) + p_T(q_s' - q^{*'})\}]$; the first term represents the loss in consumer surplus due to an increase in the equilibrium price to $p^{*'}$ and the second term to the loss in taxes. Quite clearly, L' is less than L. That is, the imposition of acreage restrictions reduces the political pressure from consumers induced by the surplus. Hence, an income payments scheme could be favored over a production quota if acreage restrictions were imposed. Thus, the conclusion of proposition 6.6 would not be altered if a price floor were replaced by a (pure) income payments scheme. A similar argument could also be made for proposition 6.5.

So far, I have dealt only with economic determinants. However, there are also political determinants. First, the theoretical model indicates that the ratio of rural to metropolitan Congressional districts is a principal political variable affecting the choice. Specifically, proposition 6.8 suggests that a decline in the ratio biases the choice toward instruments with milder production controls.[5] Second, the President has some influence over the choice. Historically, Republican Presidents favored less controls while Democratic Presidents more controls. Although this is not implied by the model, it can be discerned directly from the debates on price support legislation; the President through the Secretary of Agriculture played an active part in the debates.

The preceding discussion suggests the following hypotheses.

H1': The higher the average cost of maintaining the surplus, the greater the degree of control over production.

H2': The greater the magnitude of the surplus, the greater the degree of control over production.

H3': The larger the elasticity of demand for a commodity, the less restrictive production controls over the commodity.

H4′: The larger the supply elasticity of a commodity, the more restrictive production controls over the commodity.

H5′: The smaller the number of rural Congressional districts relative to the number of metropolitan Congressional districts, the lesser the degree of control over production.

H6′: Control over production is less restrictive under a Republican President as opposed to a Democratic President.

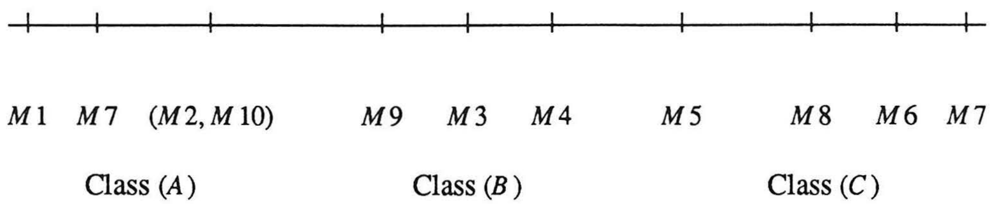
To test these hypotheses, I have divided the mixed instruments into three classes: (A) weak controls, (B) mild controls, and (C) stringent controls. The instruments are assigned to one of these classes. Table 7.4 shows where each is assigned. An instrument is assigned to class (A) if it involves little or no controls and to class (C) if it involves very restrictive controls. Instruments that are neither too restrictive nor too lax are assigned to class (B).

TABLE 7.4

Weak (A)		Mild (B)		Stringent (C)	
$M1$	(1)	$M3$	(1,2,3)	$M5$	(1,2,5)
$M2$	(1,2)	$M4$	(1,2,3,4)	$M6$	(1,2,3,5)
$M10$	(8,2)	$M9$	(8,2,5)	$M7$	(6)
$M7$	(8,7)	$M8$	(8,2,3,5)		

Notice that $M4$ is in class (B) while $M6$ and $M8$ are in class (C). This is because the Soil Bank was much less restrictive than acreage retirement programs. As mentioned earlier, the former was voluntary while the latter were mandatory. $M4$, $M6$, and $M8$ differ only in terms of their associated acreage reduction programs. The first involved the Soil Bank while the other two acreage retirement programs. Notice also that $M3$ is in class (B) while $M5$ is in class (C). $M5$ is on the borderline between the two classes. I assigned it to class (C) to generate enough observations for that class. Figure 7.5 summarizes the relative restrictiveness of each mixed instrument and the grouping of the instruments into classes.

FIGURE 7.6



Given this classification, the choice of instruments is simplified to a choice of classes. For example, if $M7$ were adopted for commodity X in 1972, then this will be interpreted as the subcommittee for commodity X choosing class (A) in 1972. An appropriate econometric model for analyzing a choice problem of this type is discussed in section D.

D. <u>An Econometric Analysis of the Choice of Instruments</u>:

An ordered probit model is suitable for studying the choice problem outlined above. In an ordered probit model, the dependent variable takes on a finite number of integer values (a categorical variable) and is ordered in some natural way, e.g., finished high school (1), went to college but did not complete (2), completed college (3), completed a graduate degree (4). Classes (A), (B), and (C) have these properties. Class (B) includes instruments with stronger controls than class (A) and class (C) with even stronger controls than class (B). Assigning the integers 1, 2, and 3 to Classes (A), (B), and (C), respectively, thus results in an ordered, categorical, dependent variable.

The ordered probit model is just a subclass within a more general class of models—econometric models with discrete dependent variables. Such models are used to study relationships between a variable that takes on discrete values and other variables, some of which may likewise be discrete. The former is treated as the dependent variable and the latter as independent variables. The "gap" between the discrete dependent variable and the independent variables (most of which are usually continuous) is bridged by some latent continuous variable. An example should clarify this.

Assume one wishes to study the relationship between a variable Z where Z takes on values 1, 2, or 3 and a set of variables V_1 through V_K. Suppose that there is some implicit variable Z^* that is related to the V_K in the following way,

$$Z^* = B_0 + B_1 V_1 + \cdots + B_K V_K + e$$

where e is an error term. And suppose further that,

$$Z = \begin{cases} 1, \text{ if } & Z^* \in R1 \\ 2, \text{ if } & Z^* \in R2 \\ 3, \text{ if } & Z^* \in R3 \end{cases}$$

where the Ri are subsets of the real number line (assume for simplicity that the Ri are disjoint). Since Z^* is random then Z is also random. That is, Z is related to Z^* in the following way,

$$Prob(Z = i) = Prob(Z^* \in Ri).$$

Assume now that data is collected. Let $(Z_j, V_{1j}, \ldots, V_{Kj})$ represent the j^{th} element in the data set (the j^{th} observation). Then, if there are T observations in the data set of which $T1$ observations result in $Z = 1$, $T2$ in $Z = 2$, and $T3$ in $Z = 3$, then the likelihood that one will observe the data set is,

$$L = \prod_{j=1}^{T1} Pr(Z_j{=}1) \cdot \prod_{j'=1}^{T2} Pr(Z_{j'}{=}2) \cdot \prod_{j''=1}^{T3} Pr(Z_{j''=3}) \tag{7.1}$$

or equivalently,

$$L = \prod_{j=1}^{T1} Pr(Z_j^* \in R1) \cdot \prod_{j'=1}^{T2} Pr(Z_{j'}^* \in R2) \cdot \prod_{j''=1}^{T3} Pr(Z_{j''}^* \in R3). \tag{7.2}$$

In an ordered probit model, the Ri in the above example are *adjacent* disjoint sets: $R1 = \{x : x \leq u\}$; $R2 = \{x : u < x \leq u'\}$; $R3 = \{x : u' < x\}$.[6] This is depicted in Figure 7.6. Hence, the likelihood of observing the data set is given by the function,

$$L = \prod_{j=1}^{T1} Pr(Z_j^* \leq u) \cdot \prod_{j=1}^{T2} Pr(u < Z_{j'}^* \leq u') \cdot \prod_{j=1}^{T3} Pr(u' < Z_{j''}^*) . \tag{7.3}$$

Let $BV^j = B_0 + B_1 \cdot V_1^j + \cdots + B_K^j \cdot V_K$ then (7.3) is equivalent to,

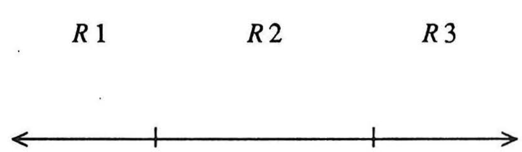
$$L = \prod_{j=1}^{T1} Pr(e_j \leq u - BV^j) \cdot \prod_{j'=1}^{T2} [Pr(e_{j'} \leq u' - BV^{j'}) - Pr(e_{j'} \leq u - BV^{j'})] \cdot$$
$$\prod_{j''=1}^{T3} [1 - Pr(e_{j''} \leq u' - BV^{j''})] . \tag{7.3'}$$

Since the error term in an ordered probit model is assumed to be normally distributed with mean zero and variance one, then (7.3') reduces to,

$$L = \prod_{j=1}^{T1} \Phi(u - BV^j) \cdot \prod_{j'=1}^{T2} [\Phi(u' - BV^{j'}) - \Phi(u - BV^{j'})] \cdot$$
$$\prod_{j''=1}^{T3} [1 - \Phi(u' - BV^{j''})] \tag{7.4}$$

where Φ is the cumulative distribution function of a standard normal random variable.

FIGURE 7.7



Note that (7.4) is precisely the likelihood function corresponding to an ordered probit model of the choice among classes (A), (B), and (C). More specifically, let Z_{ct} be the choice of the c^{th} subcommittee at time t, then the dependent variable Z_{ct} is equal to one (two;three) if the c^{th} subcommittee at time t chooses some mixed instrument in class (A) (B); C). The independent variables (the V_K in (7.4)) are given in Table 7.5. The hypotheses that each is designed to test and the "predicted" sign of the corresponding coefficient of each are also

TABLE 7.5*

Independent Variables	Hypothesis to be Tested	"Predicted" Sign of Coefficient
Real average cost of maintaining the surplus (*AC*)	$H1'$	+
Surplus as percent of total production (*SURP*)	$H2'$	+
Demand elasticity (*DE*)	$H3'$	+
Supply elasticity (*SE*)	$H4'$	+
Ratio of rural to metropolitan Congressional districts (*RURMET*)	$H5'$	+
Presidency (*PRES*)**	$H6'$	-
Dummy for shift to income payments from price floor regime (y)***	--	--

* Data for *SURP* comes from Cochrane and Ryan (1976), for *DE* and *SE* from the Staff Report of the Food and Agricultural Policy Branch of the U.S. Department of Agriculture (1985), for *RURMET* from McCubbins and Schwartz (1985), and for *PRES* from the Congressional Quarterly Almanac, Vol. 8-29. The real average cost was computed using total cost information from Cochrane and Ryan and the wholesale price index for farm products (U.S. Statistical Abstract, 1955-77); total cost was divided by the surplus and the result deflated by the index. *SURP* was computed by dividing surplus by total production; data for the surplus and production were taken from Cochrane and Ryan (1978) and from the U.S. Department of Agriculture Publication "Feed: Outlook and Situation Yearbook" (1985).

** This takes a value 1 if the President is Republican and 0 if he is a Democrat.

*** This takes a value 2 for an income payments regime and 1 for a price floor regime.

indicated in the table. Note that the expected sign for demand elasticity is positive though the hypothesis *H3'* indicates otherwise. This is not inconsistent. Demand elasticities were specified in negative rather than absolute values, the latter being the true definition of demand elasticity. If absolute values were used, then the predicted sign would be negative.

The true relationship between Z_{ct} and the independent variables is assumed to be implicitly defined by

$$Z^*_{ct} = B_0 + B_1 AC_{c(t-1)} + B_2 SURP_{c(t-1)} + B_3 DE_{c(t-1)} + B_4 SE_{c(t-1)} + B_5 PRES_{(t-1)} + \\ + B_6 RURMET_{(t-1)} + e_t \ . \qquad (7.5)$$

where Z^*_{ct} bridges the gap between Z_{ct} and the independent variables. Equation (7.5) specifies that the choice of instrument at time t depends on the values of the independent variables at time $(t-1)$. This is appropriate since the time t choice is made in the preceding period.

The parameters B_k are estimated using the technique of maximum likelihood. This involves deriving the first order derivatives of the function L (or its natural logarithm) in (7.4) with respect to all the parameters and setting them equal to zero. The values of the parameters that solve the resulting equations (the first order conditions) maximize the likelihood of observing the data set.[7] These values are called the maximum likelihood estimators of the parameters. Maximum likelihood estimators have desirable properties, among which are asymptotic consistency and asymptotic efficiency. Thus, assuming the data set is "sufficiently large," the estimators give a good approximation of the true values of the parameters; in particular, they indicate the true signs—whether positive or negative—of the parameters.

The maximum likelihood estimates of the parameters are indicated in Table 7.6 and their corresponding asymptotic t statistics in parentheses. The coefficients of the average cost and the magnitude of the surplus both have the correct signs. Likewise, the elasticity coefficients and the coefficient of the Presidency variable have the correct signs. The t-statistics corresponding to the average cost and the magnitude of the surplus, as well as to the presidency,

TABLE 7.6

Independent Variable	Estimated Coefficient	Asymptotic t-Statistic
Constant	0.0678187	0.1273905
$AC_{c(t-1)}$	.0801967	2.4906761
$SURP_{c(t-1)}$	1.0927777	4.5652057
$DE_{c(t-1)}$	.4441556	1.9742095
$SE_{c(t-1)}$	.6308068	1.3628031
$RURMET_{(t-1)}$	-.0699424	-.2106846
$PRES_{(t-1)}$	-.8395725	-4.0783627
*Threshold**	1.7116879	9.6444528

* This is an estimate of the parameter u'; u is automatically set to zero.

are significant at the 1 percent level. The statistics corresponding to the demand and supply elasticities are significant at the 2.5 percent and 10 percent levels, respectively. In other words, $H1'$, $H2'$, $H3'$, $H4'$, and $H6'$ should be "accepted."[8]

The coefficient of the variable *RURMET* has the wrong sign. But the corresponding t-statistic strongly indicates that the variable has no consequential effect on the choice of instruments. That is, $H5'$ should be rejected. It may be the case that the decline in the ratio of rural to metropolitan Congressional districts played a more important role in the bargaining between rural and urban legislators and only a minor role in the subcommittee deliberations, where the choice of instruments was generally ironed out.

The statistical evidence presented in this chapter tends to support the implications of my proposed instrument choice model. The model suggests specific relationships between the degree of control over production and certain economic and political variables. The evidence supports the suggestions.

FOOTNOTES

1. The Set Aside program was also mandatory.

2. Because of its mandatory nature, an acreage retirement program resulted in a larger reduction in acreage than the Soil Bank .

3. The latter two are roughly descriptive of the way price support legislation works.

4. The proofs are essentially the same. It is not clear whether the proof of proposition 6.5 would also go through. For the empirical analysis, it does not really matter whether it does; the impact of technological change is not tested directly.

5. This assumes, of course, that less controls are accompanied by lower price support levels. Again, this tends to be the case.

6. The term u is assumed to be zero. This does not affect the results as long as one of the regressors is a constant.

7. The log likelihood of L is guaranteed to be globally concave, and so the solutions to the first order conditions are maximizers of L.

8. Some caution must be exercised in interpreting the effect of the elasticities. Due to the unavailability of elasticity estimates for each of the twenty years for all but one of the commodities, the same elasticity estimates were used for all the years. The estimates come from the FAPSIM (farm policy simulator) model recently developed by the U.S. Department of Agriculture. I was able to get estimates of the supply elasticity of tobacco for the mid to the late fifties. I used this estimate for the first part of the period (1952-63) and the USDA estimate for the second part of the period (1965-72).

   Note, though, that deleting the elasticity variables does not alter the results (qualitatively) for the remaining variables. The regression estimates without the elasticity variables are shown below; $H5'$ is once again rejected, but the rest are "accepted" at the one percent level.

Variables	Estimated Coefficient	t-Statistic
Constant	0.0315296	0.0742539
$AC_{c(t-1)}$	.0840030	2.8764678
$SURP_{c(t-1)}$	1.3595608	6.9421323
$PRES_{(t-1)}$	-.8518403	-4.2574512
$RURMET_{(t-1)}$	-.1723448	-.5522314
Threshold	1.6829895	9.6023266

9. I have not investigated and will not investigate the choice between a price floor and an income payments scheme. Cochrane (1978) has argued elsewhere that the switch to the latter was motivated by the desire of farmers to regain the loss in export shares propagated during price floor regimes. A price floor regime induces farmers to sell to the government instead of exporting production in excess of domestic demand.

CONCLUSION

This manuscript has been about price supports: why they exist and why they are implemented in different ways across markets and over time in a specific market. The first four chapters of the manuscript were devoted to the first question, existence, and the last two chapters to the second, the choice of regulatory instrument. One chapter, the fifth, bridged the gap between the two parts.

In the first chapter, I presented the basic argument forwarded by economists to rationalize the existence of price supports. I argued that their contention is flawed because it assumes a mechanism inconsistent with the way price support programs actually work. In chapter two, I discussed an alternative rationale: two types of models that political scientists might use to explain why policy outcomes might be inefficient. I pointed out their weaknesses, namely, that they fail to adequately account for the obvious link between economic forces, the preferences of decision makers, and policy outcomes, and that they assume a world in which either pure cooperation among or pure conflict between legislators is the norm. In chapter three, I identified conditions sufficient for legislators with naturally conflicting preferences to form a winning coalition in order to guarantee passage of a mutually beneficial package of bills. In chapter four, I then developed a model better suited for explaining the existence of price supports and derived comparative static results from which certain hypotheses were generated. I tested some of the hypotheses against data from U.S. feed grains markets and found the test results consistent with the hypotheses. The model rectified the deficiencies of the political models and, on the basis of arguments in chapter three, assumed some form of bargaining between legislators with conflicting interests—those who favor price supports and those who do not—is possible.

The economic literature on regulation has dealt mostly with the inefficiency problem. In particular, the traditional economic cost-benefit approach to regulation and the new economic theory of regulation focus principally on the problem. In chapter five, I summarized and criticized the two models at the cutting edge of the new theory, the Stigler/Peltzman model and the Becker model. Both recognize the connection between economic factors and policy outcomes but, unfortunately, de-emphasize the role of political institutions in shaping policies. Thus, neither deals satisfactorily with the problem. And so neither is a better alternative to my proposed existence model.

Regulation takes many forms. But with few exceptions political scientists have downplayed this characteristic. They have been mainly concerned with the study of inefficient policy outcomes. In one way or another most economists are equally guilty. Stigler and Peltzman, for instance, implicitly assume that differences in regulatory form are unimportant. Becker deals with these differences. But he does so simplistically since he assumes that the influence of institutions is inconsequential. In sum, existing models cannot adequately address the instrument choice problem.

In chapter six, I constructed one such model. Roughly speaking, the model generalized my existence model and expanded the latter in a way that made it suitable for analyzing the choice of regulatory instrument. To some extent, it could be viewed as a natural extension of the Stigler/Peltzman model. I concluded the chapter with an application of the model to the choice of production control methods in the implementation of a price support program. I derived a series of comparative statics results, which I then used in chapter seven to generate hypotheses about the nature of production control over eight agricultural commodities whose prices where supported during the twenty-year period, 1953-72. I undertook an econometric analysis of the data for these commodities during the said period and basically concluded that the data could not reject the hypotheses.

Although the manuscript deals mainly with price supports, its principal contributions are easily generalizable. These are, first of all, the bargaining power of a committee within an institutionally constrained legislature, and second, the choice of instruments in the regulation of markets.

For all its power, Shepsle's model of a legislature does not satisfactorily explain how small minorities—that is, committees—secure legislative majorities, even though it may account for stable outcomes. By insisting on the radical independence of policy dimensions (the orthogonal basis vectors), it fails to appreciate the significance of the ability to trade across jurisdictions and thus fails to account for the actual occurrences of logrolling arrangements, implicit or explicit, among legislators. I have partially rectified this deficiency by introducing the notion of an extraneous jurisdiction within the model's framework. A jurisdiction is a policy issue over which a committee has authority; it is extraneous if it does not yield benefits to constituents of legislators within the committee but could potentially benefit constituents of legislators outside the committee. I have shown that, under fairly weak conditions, a committee could use an extraneous jurisdiction to create and successfully defend a winning coalition with noncommittee members.

Jurisdictional arrangements are generally taken as a given in most studies of Congress. The enormous workload of Congress requires an appropriate division of labor whereby committees specialize (and presumably have some comparative advantage) in certain areas of legislation. This results in a mapping of committees to jurisdictions. However, the mapping may not be as neat as has been presumed. If part of the power of a committee lies in its control over an extraneous jurisdiction, then it would seem that some competition for that jurisdiction would take place. Indeed, this appears to be the case for food stamps. I think that it is worthwhile to study the nature of such competition, for it adds a new dimension to the institutional world of Shepsle. As legislation becomes more complex, new jurisdictions will be created, some and perhaps many of which will fall into "gray areas." Competition is then likely to result.

A regulatory policy is instrument dependent. That is, it cannot be divorced from the method of implementation. One simply cannot talk concretely about a particular regulation without discussing how it is to be implemented. Price support policy is invariably associated with price floors, income payment schemes, and acreage restrictions. Likewise, trade policy is characterized by tariffs, import quotas, and a variety of other instruments. A positive theory of regulation must of necessity account for such variation.

I have taken a step in this direction by developing an instrument choice model for an individual legislator. However, more work needs to be done on the instrument choice problem. Like Stigler (1970) and Peltzman (1976), I essentially bypassed the legislative process in deriving my conclusions. But, as I indicated in chapter four, the elements within and the nature of the process play a significant role in determining policy outcomes. Specifically, the choice of instrument is made at the very least by a subcommittee, not just a single legislator. The subcommittee must choose both the instrument and the appropriate tax rate. Assuming the members of the subcommittee are sophisticated enough, they will realize that the tax rate that will be chosen for each instrument will correpond to the choice of the median voter under the instrument. Thus, each will choose that instrument which yields the highest gain at the corresponding median voter tax rate. Certain conditions will determine which instrument generates the most votes for a legislator. I speculate that the composition of the subcommittee will have some impact on the choice. For example, in the case of price support policy, a production quota is biased in favor of consumers since it yields lower losses and gains relative to a price floor at the same price support level. Thus, if the subcommittee is staffed with legislators who are only mildly supportive of farmers, then given a choice between a price floor and a production quota, it would choose the latter.

Although my dissertation focuses on price support policy, it does have some implications for policy analysis in general. With some adjustments, the methodology I use can probably be adopted in studying other policies. Ultimately, my goal in writing this manuscript is to convince others that a better understanding of the policy process, particularly the restrictions that political constraints impose on it, will lead to better policymaking.

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