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THE INCIDENCE OF MARKET-STABILIZING PRICE SUPPORT SCHEMES

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Prominent among government interventions into markets for agricultural and other primary products are various programs for supporting producer prices. Many of these schemes, that for dairy products in the United States for example, have a fairly obvious price-raising rationale. Here we consider the implications of schemes, such as measures for supporting grain prices, that might be defended as market-stabilizing in that their support levels are below the mean price. Even if market participants are risk neutral, such schemes can significantly affect their welfare.

One such scheme involves deficiency payments which the government pays producers as the difference, if positive, between a target price and the market price. Another is a floor price scheme of the simplest type, in which the government, or an association of producers, makes an open offer to buy or, subject to availability of public stocks, to sell the commodity at a 'floor price.' Floor price schemes are more common in practice than deficiency payments. They are also more complex interventions, directly affecting both production and private storage.

Schemes involving price floors tend to follow a familiar pattern. Producers complain of a large quantity 'overhanging' the market and of the low incomes that result. The government responds by purchasing the surplus and raising the current price, with the intention of selling later when the market is stronger. Yet, after only a few years have gone by, producers again articulate the complaint, confirmed by impartial observers, that their incomes have fallen despite the program. Pressure mounts for a higher support level, the sequence then repeating itself.

This apparent failure of most price floor schemes, which has important political consequences, is sometimes attributed to secular decline in the terms of trade for primary commodities. Another cause lies in the differences between the initial effects and comparative statics effects of the schemes. Acquisitions for the stockpile boost producers' revenues in the early years of a scheme. But after it has been in operation for a long time, average revenue for producers may well be lower than if no scheme existed. The present value of the income path can be positive even if the long-run effect on producers' income is negative. Whenever the present value of the income path is positive, producers will rationally support floor schemes, although they will repeatedly argue for a higher floor, in order to benefit from the boost provided by the additional accumulation of government stocks.

Thus, dynamic effects determine who benefits, and by how much, from the program's introduction. The crucial inter-period connections, forged by storage and responsive supply, determine the initial effects of a commodity program and the subsequent evolution to the new stochastic steady state. Unfortunately, the dynamic effects can be deduced only from numerical solution of a model of a commodity market. On the other hand, comparative statics effects can be assessed analytically, and perhaps that explains why they have been the focus of most previous studies of market stabilization (e.g. Newbery and Stiglitz 1981 and references therein). But they do not adequately indicate the incidence effects that are the subject of this paper.

We begin in Section 1 with an outline of a model with a simple price support scheme. Then we discuss in Section 2 the implications of a price support scheme in the steady state, assuming it stabilizes consumption. In Section 3 we consider the dynamic evolution of the model after a policy change, and this discussion leads to an assessment of the incidence effects of price supports in Section 4, including the contrast with comparative statics results. In Sections 5 and 6 we consider the implications of responsive supply and risk aversion, and conclusions follow in Section 7.

1. A Market Model with a Random Disturbance and Private Storage

Under a scheme either of deficiency payments or of a price floor, government intervention in any low-price period is price-stabilizing for producers, in the sense that it moves current producer price toward the mean of its post-stabilization distribution. When making deficiency payments, the government pays producers the difference, if positive, between a 'target price' P^T and the market price P_t paid by consumers in period t. So under this scheme, producer price P_t^* is

$$P_t^* = \text{Max}(P_t, P^T) \tag{1}$$

Under a floor price scheme, the government ensures that the producer price, which is also the market price, does not fall below the floor price P^F:

$$P_t^* = P_t \geq P^F \tag{2}$$

The floor price is defended by an open offer to purchase any amount at P^F. In a so-called 'price band' scheme, resale of stocks so acquired may be triggered at a price above P^F. Here we consider only the simpler case in which the government stands ready to buy or sell (subject to its having a sufficient quantity in store) any amount at P^F. Both the target price P^T and the floor price P^F are assumed to be below the free-market mean.

From producers' perspective, less simplistic government rules may be superior. But the prevalence of relatively simple or arbitrary rules implies that governments find it difficult to identify and implement more complex alternatives. Indeed Wright and Williams (1982b) show that the conventional stochastic dynamic programming strategy for investigating such policies encounters a problem of the type identified by Kydland and Prescott (1977): the 'state variable' is a function of private storage and production, which in turn depend upon expectations of future public storage behavior.

Apart from the presence of public storage and deficiency payments or price floors, the market model sketched in the next several paragraphs follows that developed for undistorted private storage in Wright and Williams (1982a). For the incidence of support schemes, three characteristics of the model are particularly important: the degree of curvature in the demand curve, the supply elasticity, and the nature of the random market disturbance.

We specify the stationary inverse consumption demand for the commodity in each period as

(3) $$P_t = a + bq_t^{1-C}, \qquad \partial P/\partial q < 0$$

where P_t is the market price in year t and q_t is the quantity consumed. Income is assumed constant for consumers throughout, so the income term is suppressed in (3). This form includes the linear ($a > 0$, $b < 0$, $C = 0$) and constant elasticity ($a = 0$, $b > 0$, $C > 1$) specifications. The relative curvative of the demand curve is constant in (3), and is measured by $C \equiv -q(\partial^2P/\partial q^2)/(\partial P/\partial q)$.

We consider two alternate assumptions regarding the market disturbance. One is that production h_t is subject to a disturbance proportional to the amount of the planned harvest $\bar{h}$, which must be chosen in period t-1. The short-run (within-period) supply response is assumed to be zero.[2] The supply function is therefore

$$h_t = \bar{h}(P_t^r)[1 + v_t] \tag{4}$$

where the disturbance v_t is drawn from a distribution which is serially uncorrelated, with mean of zero and finite variance, and P_t^r is the marginal incentive as of period t-1. Assuming all atomistic producers share this multiplicative disturbance, under rational expectations (see Wright (1979)) P_t^r is

$$P_t^r = \frac{\partial E_{t-1}[P_t^* h_t]}{\partial \bar{h}_t} = E_{t-1} \frac{[P_t^* h_t]}{\bar{h}_t} \tag{5}$$

where E_{t-1} denotes the expectation operator given the information available in period t-1. Atomistic profit-maximizing producers individually view price as exogenous to their production decisions, but recognize that their own production disturbance will affect price because it is shared by others. P_t^r is a function not only of the mean but also of higher moments of the distribution of the disturbance v_t in (4) above.

The alternate assumption is that the stochastic disturbance shifts market demand. We attribute the shift in market demand observed by producers in the region or country of interest to what is in fact the most usual cause, namely random fluctuation in excess demand from other regions or countries, reflecting production disturbances therein. Since excess demand is assumed to be unresponsive to incentives, perhaps because of price controls in the foreign market, these fluctuations are exogenous to the model. The supply function is in this case

$$(6) \qquad h_t = \bar{h}(P^r_t) + w_t$$

where w_t is i.i.d. with mean zero and finite variance. (With such an additive disturbance, P^r_t equals expected price.)

If the disturbance is fixed at zero, production and consumption is q^N, price is P^N, revenue is R^N, and storage equals zero. Otherwise, the quantities produced, consumed, and stored satisfy the following market-clearing condition:

$$(7) \qquad q_t = h_t + S^c_{t-1} + S^g_{t-1} - S^c_t - S^g_t = A_t - S_t$$

where $S_{t-1} \geq 0$ is total storage from period t-1 to period t, comprising private storage, S^c_t, and government storage, S^g_t, and A_t is the amount available in period t, the commodity when previously stored being indistinguishable from new production.

Competitive private storage, if strictly positive, equates current consumption price P_t to the return from the next period, net of marginal storage costs k_t, assumed constant, and interest costs at rate $r > 0$. Thus, for private storage the familiar complementary inequalities hold:

$$(8) \qquad \begin{array}{ll} 0 > (1 + r)^{-1}E_t[P_{t+1}] - P_t - k_t, & S^c_t = 0 \\ 0 = (1 + r)^{-1}E_t[P_{t+1}] - P_t - k_t, & S^c_t > 0 \end{array}$$

These conditions implicitly determine the amount of private storage as a function of the amount available and the floor price,

(9) $S_t^c = f^F(A_t, P^F), \quad 0 \leqslant \partial f^F/\partial A$

The government's behavior is determined by its commitment to buy or sell any amount, subject to the availability of stocks, at the floor price. Thus,

(10) $S_t^g = \text{Max}[A_t - S_t^c - q^F, 0], = g^F(A_t, P^F)$

where q^F is amount consumed at the price floor, $P^F = a + b(q^F)^{1-C}$.

In examining the incidence of public price supports, we assume that the market is initially in a stochastic steady state. Upon the simultaneous announcement and introduction of the price support scheme, assumed permanent, the market suffers an initial perturbation, then follows a path that converges to the new steady state, as shown in the example in Figure 1. The initial steady state revenue is the random variable R_{ss}. At period 0, when realized revenue of producers, who are assumed to own all of the large available supply, would be R_o, the introduction of a floor price scheme shifts the revenue realization to R_o^F. Conditional on the information set Ω_o available at period 0, the path of expected revenue years in the future is given by $E(R/\ \Omega_o, P^F)$ which converges to mean revenue in the new steady state R_{ss}^F. In the next three sections we shall consider, first, the effect of price supports on current flows in the steady state, then the nature of the dynamic path, and finally the full incidence effects of the schemes on individuals.

2. Multi-Period Comparative Statics

Obviously, under a deficiency payment scheme, financed in a lump-sum fashion, storage is not directly affected by the target price. Any effect is induced indirectly, via the production response. Therefore, the first proposition is:

<u>Proposition 1:</u> If supply elasticity is zero, a deficiency payments scheme with lump-sum financing affects only producer income.

The effects of a floor price scheme are more interesting. In the stochastic steady state mean consumption equals mean production. Then as long as supply elasticity is zero the scheme does not alter mean consumption, regardless of the existence of private storage. If the floor is in general consumption-stabilizing, then the change in consumption is a mean-preserving reduction in its dispersion, the opposite of a mean-preserving spread (Rothschild and Stiglitz 1970). This implies the following proposition regarding price:

<u>Proposition 2:</u> If the consumer demand curve is stationary, and linear or convex in the range of possible consumption, and supply elasticity is zero, a floor price scheme cannot raise mean price in the steady state.

For the demand specification (3) above, P is convex (concave) in q as $C >$ ($<$) 0. For the linear specification ($C = 0$), mean price is unaffected by a floor price, while for the constant elasticty specification ($C = (1 - 1/\eta^D)$ > 1) a reduction in the dispersion of quantity consumed reduces mean price.

Of course revenue, not price, matters to producers. The effect of a price floor on mean revenue or on mean consumer expenditure, Pq is also sensitive to the demand specification. From (3),

$$\text{(11)} \qquad \partial^2(Pq)/\partial q^2 = (2 - C)(1 - C)\, bq^{-C} = (2 - C)\partial P/\partial q$$

<u>Proposition 3a:</u> When supply is perfectly inelastic, and the disturbance is in production, the comparative statics effect of a floor price scheme on mean consumer expenditures is positive (negative) as C is less (greater) than 2.

Thus, in the linear case for example, mean revenue always increases with the floor price, but for the case of constant elasticity, mean expenditure decreases (increases) if demand is price inelastic (elastic). These expenditures go both to producers and to private storers, but the latter, by our assumption of competition along with constant marginal and average storage costs, make zero profits on average.

<u>Proposition 3b:</u> When the disturbance is in production, and supply elasticity is zero, the comparative statics effect of a floor price scheme on mean producer revenue is of the same sign as $(2 - C - K(\Delta S^c))$ where ΔS^c is the expected steady state change in private storage, $K(0) = 0$, and $\partial K/\partial(\Delta S^c) > 0$.

The function K reflects storage costs and can be determined numerically.[3] But what if local producers face a random disturbance in market demand, as in (6) above? Then, if the local producers have fixed, nonstochastic production, the effect on their expected revenue is proportional to the effect on expected price in Proposition 2.

<u>Proposition 4:</u> Producers have a comparative statics loss of expected revenue from the stabilization of an exogenous additive disturbance to market demand if $C > 0$.

How do consumers fare under consumption-stabilizing price supports? The steady-state effects on the representative consumer, under zero supply elasticity, depend on the convexity or concavity of the indirect utility function V(P,Y). The following proposition is proved in Wright and Williams (1984a, p. 171):

<u>Proposition 5:</u> The comparative statics effect on consumer welfare of stabilization of consumption, under zero supply elasticity, has the sign of the coefficient of relative commodity risk aversion with respect to quantity consumed at the (variable) market price, defined as:

$$\text{(12)} \qquad \rho_c \doteq -q \frac{\partial^2 V/\partial q^2}{\partial V/\partial q} = C - 1 + (\gamma/\eta^D)(\eta^Y - \rho_Y)$$

where γ is the budget share, η^Y is the income elasticity of demand, and ρ_Y is the Pratt-Arrow coefficient of relative risk aversion with respect to Y.

What are the implications of introducing positive finite supply response? For producers, positive supply response mitigates but does not reverse the distributive bias of a floor price scheme, reported in Propositions 2 through 4. Similar findings were derived for 'ideal production stabilization' in Wright (1979), and for the comparative statics effects of profit-maximizing private storage in Wright and Williams (1982a).

However, with a multiplicative supply disturbance (4) the increase in steady state supply at low values of C, due to the response of P^r, (5), means that consumers can now gain from stabilization over a wider range of C than indicated in Proposition 5. But at higher values of C, or with an additive disturbance (6), mean production and consumption are decreased, reducing any consumer gain from greater consumption stability.[4]

When supply elasticity is positive, deficiency payments increase mean consumption and production but restrict the complementary interactions of private storage and production described in Wright and Williams (1982a). Hence they reduce the stabilizing role of storage, and destabilize consumption and price. How do floor price schemes affect government expenditures? Until recently it was standard practice to assume no private storage at all when examining the prospects for public buffer stock schemes. (Exceptions are Helmberger and Weaver (1977), Sharples (1980), Gardner (1979) and Wright and Williams (1982b).) If private storage is ignored, the government may possibly run a storage scheme at a profit. But it seems more reasonable to assume expected- profit-maximizing[5] competitive[6] private storage whether or not the government intervenes. Under these conditions the private market will compete away any expected profits if the government has no cost advantage, while the private sector will avoid expected losses. Thus, we have:

<u>Proposition 6:</u> If expected-profit-maximizing competitive private storers exist, the government, except in the limiting case of breaking even, suffers an expected revenue loss from any floor price scheme.

These analytical propositions have all been checked by extensive numerical analysis. To solve the stochastic dynamic programming problem for the private storage rules under deficiency payments and price floors, denoted by functions $f^D(A_t, P^T)$ and $f^F(A_t, P^F)$, and to calculate welfare effects, we use a method similar to that described in Wright and Williams (1984a) modified to take account of the support measures.

We assume parameters roughly consistent with those of U.S. grain markets. The consumption demand elasticity is -0.2 at the nonstochastic equilibrium and the budget share is very small, justifying use of expected consumer surplus as an approximation to <u>ex ante</u> compensating variation (Wright and Williams 1984c). The disturbance has a symmetric[7] five point distribution expressed in terms of mean production of -15%, -7.5%, 0.0%, +7.5%, and +15.0% with probabilities 0.05, 0.20, 0.50, 0.20, and 0.05 respectively. Marginal storage costs, whether public or private, are 2.5% of P^N, and the interest rate is 5%. The results of simulations (7500 periods) of this model were used to approximate the steady state effects of price supports. They uniformly confirm the analytical propositions of this section, summarized in Table 1.

3. The Dynamic Evolution of Producer Income

The effect on revenue of a floor price scheme can diverge greatly from the long-run steady state effect for many periods after its introduction. This is obvious from Figure 1, which was generated using the numerical methods discussed above. Therefore, to assess the incidence of a scheme, it is necessary to go beyond the comparative statics results of the previous section and consider explicitly the dynamic evolution of the effects of the scheme. The expected time path of producer revenue as of the introduction of a support price equal to 90% of the price P^N, less the path expected without the price support, is shown in Figure 2 for two levels of initial availability. The base case (panel 2a) is the case shown in Figure 1. Demand has constant price elasticity, curvature parameter C equals 6.0, supply elasticity is zero, and the disturbance is located in production. The other five cases show the relative importance of variations in specification.

In each panel of Figure 2, the sequence denoted by dots represents the case in which a large amount of the commodity, 120% of q^N, is initially available. (Presumably, a support scheme would be more likely to be introduced if current price were unusually low.) Producers are assumed to own all initial availability. (If they do not, their gains in period 0 are overstated.) Subsequently, the luck of the sequence of draws of the random disturbance determines the precise path and whether, ex post, the scheme has raised or lowered income in any given period. Several periods into the scheme, by chance the course of the random disturbance may have been such that the price support scheme benefited producers every period so far. With another sequence, the buildup of public stocks may have been so great over the course of several periods that when a small harvest occurred, one that with the smaller stocks accumulated without a floor would have raised price substantially, price remained low, and as a result income was much lower than it would have otherwise been. The discrete sequences in Figure 2 present the average of 10,000 of these paths, each followed for eleven periods from the introduction of the scheme.

All the dotted sequences in Figure 2, beginning from a large initial availability, show the price floor eventually becoming, on average, a less effective income support as time goes by. This decay in effectiveness of income support holds also for deficiency payments (panel 2f) when the initial availability is large, in which case it represents convergence towards the comparative statics differential discussed above. But in contrast to the case of price floors, the decline is monotonic.

The paths of small squares in Figure 2 indicate cases in which the initial conditions were low availability (90% of q^N) and high price. In these cases the announcement of the floor price scheme antedates the initial aquisitions of government stocks. With a price floor, the path of the differential in revenue rises initially, because expected net acquisitions for the government stock are positive for a number of periods after the time of introduction. (Because initial availability is so low, it is likely that the first acquisitions will not occur until several periods have elapsed.) The expected path eventually turns downward, to converge on the steady state differential, which is negative under a price floor if C exceeds 2-K. In the case of a deficiency payments scheme introduced when the market is tight, the expected revenue path increases monotonically to the steady state level.

4. The Incidence of Price Supports

The steady state results for producer surplus, and the dynamic paths, help us to understand how price supports change the path of income flows in a commodity market. But the change in current income in any period does not indicate the incidence on current producers. Upon the (unanticipated) implementation of a permanent support scheme at time t_o, the value of land[8] and the price of the commodity will adjust immediately to new dynamic equilibrium levels, assuming full Ricardian capitalization.[9] Assuming risk neutrality, the change in land value is the expected present value at t_o of the change in the income flow from land, from the time of the next harvest, t_1, to infinity. Any expected net gains or losses from the program accrue to those owning, at t_o, land or the commodity. Their change in wealth equals the change in land value plus the change in the value of initial stocks.

The near-term boost in demand associated with accumulation of public stocks may be sufficient to raise producers' wealth, assuming they own the land at the time of introduction of the scheme, even if the long-run effect on income is negative. Quite simply, the initial boost occurs because the government must buy before it can sell, and it is important because the long-run steady state is heavily discounted.

A convenient summary of the distributive effects of various price floors and deficiency payments on producers and consumers is presented by surplus transformation curves, such as those in Figure 3. Gardner (1983) and Josling (1974) use similar curves to show the comparative static effects on current surplus flows of price-raising schemes in the context of a deterministic market (where stabilization cannot be an issue). In Figure 3, the origin represents the initial free market situation. Consumer and landholder benefits are measured by the expected present value of consumer surplus and producer surplus respectively, expressed as a percentage of R^N, the product of P^N and q^N defined above. Here it is assumed that the scheme is financed with a lump-sum tax on producers. Thus, the curves indicate whether an association of risk-neutral producers, rather than the government, would find it advantageous to initiate a floor price scheme or make deficiency payments.

For the case of zero supply elasticity and constant elasticity of demand, the surplus transformation curve OA in Figure 3 shows the effects of introducing various levels of price floors in a year t_0 in which availability A_0 is 120% of q^N, so that there will be a large carryover in storage. Selected price floors are marked on OA, as fractions of P^N. Unlike the surplus transformation curves for price supports in a deterministic model, which raise mean producer price (Gardner 1983), the curve OA is non-concave. For floors up to 85% of P^N, producers lose while there is a net transfer to consumers present and future. For higher floors the schemes are much less favorable to consumers. At the 90% level, for example, the scheme reduces wealth of current producers and the welfare of present and future consumers. But if price is 95% of P^N, current producers have a clear gain in wealth from the scheme while consumers lose.

The difference in the desirability of various floors can be explained as follows. The current effect of an early purchase at the floor price is to increase current producer surplus and reduce current consumer surplus. Subsequent resale reduces that period's producer surplus and increases consumer surplus, and these current effects, at high values of C, dominate in magnitude the initial requisition effects. When the price floor is 80% of P^N, the effect of the scheme is to increase total stocks in periods of surplus, but this increment is typically resold fairly quickly, once the market price rises above the floor, as illustrated in panel b of Figure 2. The expected duration of holding is sufficiently small that the net effect is an increase in the present value of consumer surplus, and a fall in the value of land plus stocks held at the time of introduction of the scheme. When the price floor is closer to the free market mean, as in panel a of Figure 2, buffer stock additions are more frequent, and releases occur more rarely, in the early periods. Thus, the expected holding period of an early marginal increment is of sufficiently greater duration that the initial welfare effects dominate, so that the scheme favors producers at the expense of consumers.

The vertical distance to the surplus transformation curve, from the diagonal OC, the locus of fully efficient transfer, measures the total dead-weight loss of a scheme. A slope of greater than -1.0 indicates a marginal dead-weight loss from an increase in the price support. Deficiency payments when supply is perfectly inelastic have no dead-weight loss. The transfer to producers equals the cost of the scheme, so with producer financing the relevant transformation curve collapses to the origin 0. On the other hand, price floors can have a substantial dead-weight loss for high floors, approaching 40% of budgetary expenditures on average and 65% at the margin.[10]

The dead-weight loss from a price floor supported through public storage arises precisely because storage is socially excessive. Too much is held in store and for too long, on average. Much of the budgetary expense, which might otherwise go to producers, is wasted through excessive physical storage and interest costs.

Given the wastefulness of storage expenses in a floor price scheme, destruction upon acquisition at the price floor, or other extra-market disposal such as foreign aid, of some part of the supply might be a superior policy. In the constant elasticity demand specification with zero supply elasticity it is easy to show that in a comparative statics analysis the response of producer surplus (PS) and consumer surplus (CS) to marginal destruction of output is

$$d(PS)/d(CS) = -(2-C)/(1-C) \tag{13}$$

which, in the example with C=6, equals -0.8. In Figure 3, the curve OE, generated numerically, shows the tradeoff for A_0 equal to 120% of q^N. Its slope, which is very close to -0.8, is steeper than that of OA. The deadweight loss is less than half of that of a price floor. The excess costs of storage are, of course, far less obvious than those incurred by dumping grain in the ocean or burning it, so the more costly method may be more politically palatable. In some circumstances a method of removal of product more acceptable to self-interested domestic producers may be foreign 'aid', especially if the recipients are effectively segregated from commercial markets. Such aid may be far more efficient as a means of domestic transfer to producers than a floor price scheme, even if any benefit to the recipients is entirely ignored.

Results for the other specifications offered in the literature, with the same consumer demand curve and initial availability, are also shown in Figure 3. The inclusion of private storage in the model is dramatically vindicated by comparing curve OA with curve OF, which holds private storage at zero. The curve OF would lead to two wrong inferences about price floors. First, without private storage, a floor price scheme with the floor levels shown appears more (incrementally) efficient than a lump sum transfer (represented by the diagonal OC) because it is a good substitute for the absent, and socially valuable, private storage. Second, it would appear producers would never gain from such a scheme, with this demand specification. The importance of recognizing dynamics is emphasized by curve OG which shows the comparative statics results of a floor price scheme with private storage. From them it would appear consumers gain and producers lose over the whole range of price floors whereas the true incidence combinations cover any of three quadrants, as shown by curve OA. A further erroneous inference from the comparative statics measure is that a low price floor could increase net social welfare, since the deadweight loss, measured by the distance from OC, appears to be negative. This apparent social gain reflects the fact that the cost of the expected accumulation to the stochastic steady state is ignored. The only cost of stocks considered in the comparative statics is the current physical storage costs k.

If, as specified in equation (6), the disturbance acts as a shifter of market demand, then the surplus transformation curve is OH. Clearly a high floor price is very inefficient, in terms of the interests of all participants within the market considered, and can decrease both expected consumer welfare and producer wealth. The reason for this is easy to understand. The market demand shifter is excess foreign demand, which is by assumption unresponsive to price and has a mean of zero. The domestic market gains by selling in times of positive excess demand, and buying, at a lower price, at times of positive excess supply. Stabilization of price reduces this arbitrage advantage, and favors the country that is the source of excess demand (whose welfare is not taken into account here.)[11]

One would rightly suspect, from consideration of the comparative statics propositions in Section 2, that the demand curve parameter C would be crucial in Figure 3. Figure 4 shows the surplus transformation curves when the consumption demand curve is linear (C=0). Here the direction of the distributional results is generally in favor of producers. Curve OA shows the surplus transformation achieved by a price floor scheme introduced when A_0 is once again equal to 120% of q^N.

Curve OH shows the surplus transformation when there is an exogenous disturbance in demand. Once again the transfer at high floor levels is very inefficient from a domestic viewpoint, since the 'foreign' participant gains from the stabilization scheme. On the other hand destruction, shown by curve OE, is less efficient relative to the floor price scheme (OA).

Recent policy choices (for example the United States PIK program) indicate that the public sector may be more concerned with budget costs than with welfare. Figure 5 compares the wealth transferred to producers, gross of budget costs, to the present value of the budgetary expenditures under a selection of programs. Curve AA, which represents the standard case (η^D = -0.2, C=6) for initial availability of 120% of q^N shows that deficiency payments dominate in transfer per budget dollar. Curve HH shows that if there is an exogenous foreign disturbance in market demand, a price floor scheme is inefficient in converting budget resources into producer wealth. This is not true in the same circumstances if demand is linear (C = 0), as shown by curve JJ. Linear demand implies higher budget efficiency if the disturbance is in supply, as shown by curve KK, and higher levels of transfer are achieved more efficiently by the floor price scheme than by deficiency payments. All of these results are in line with those of Figures 3 and 4. But the case of destruction or extra-market disposal is different. For the standard case, curve OE shows that producers gain far more per unit expenditure under this policy than under price floors or deficiency payments, and this is also true in the linear case (curve OF). For equivalent producer gain, the average amount purchased for destruction is so much less than the average amount stored that the expected present value of the net costs of extra storage exceeds the cost of purchase for destruction.

5. The Implications of Responsive Supply for Incidence

Thus far in our discussion of incidence we have assumed that planned production $\bar{h}$ is fixed and producers do not respond to changes in their incentive P^r. In the comparative statics analysis reported in Table 1, the effect of such responsiveness is very predictable--it reduces the bias in the 'redistribution' caused by the price floor, but it does not alter the sign of the bias.

In the comparative dynamic analysis, the interaction is more complex. As discussed in Wright and Williams (1982a), responsive supply complements private storage in stabilizing the market after a shock. If there is a shortage, planned supply expands and raises expected production in the next year. If there is a glut, the opposite happens. The implications for incidence in our standard case are shown in Figure 6 for a floor price increased to maintain a constant expected net present value of expenditures.

When supply elasticity η^s is between 0.02 and 0.39, the introduction of this floor when A_0 is 120% of q^N increases net wealth of current producers, even if they pay the costs of the scheme, by reducing the fall in their land value more than it reduces the gain on initial stocks. The extra storage incurred by the initial defense of the floor is expected to be held for such a long period before resale that the earlier income-boosting effect outweighs the greater, but much later, income-reducing effect of resale. But supply response, if non-negligible, will greatly reduce the expected duration of this prior boost in storage, because the present value of the income-reducing resale becomes more significant.

Figure 6 shows that, contrary to the comparative statics analysis, responsive supply can reverse the incidence of price floors. The reversal is more dramatic if producers do not own all the initial stocks, or if initial availability A_0 is lower at the time of the introduction of the price floor policy. In both cases initial producers tend to fare worse at any supply elasticity than shown in Figure 6, and they may even suffer a net loss of wealth under elastic supply. If demand is linear, on the other hand, the redistribution towards producers shown in Figure 4 is reduced, but not reversed, by elastic supply.

A plausible extrapolation from the standard deterministic model might lead one to believe that a higher supply elasticity would lead to greater average production, and excess burden, at a higher price floor. But Figure 6 shows that, in fact, the present value of the excess burden decreases with supply elasticity at a given expenditure level before rising again at higher elasticities. The presence of supply response itself makes the effect of a floor less important, and the prospect of resale of stocks dampens supply expansion. As it happens in the case illustrated in Figure 6, mean long-run supply in the comparative statics sense decreases 0.19% at $\eta^s = 1$. Under deficiency payments, on the other hand, long-run supply response is positive, in line with conventional intuition.

6. Stabilization and Risk Aversion

What are the implications of risk aversion for the effects of producer price supports? The answer depends very much on the way the problem is modeled. If producers are risk averse over current farm income, if they cannot save at all, and if their utility functions are intertemporally separable, then it is clear that, ceteris paribus, they gain from income stability. Although achievement of completely stable consumption and price would destabilize income from random production, in most realistic cases, with inelastic consumption demand, price supports will stabilize producer income. But what happens to its mean? Just and Hallam (1978) present a model in which a firm respond positively to the mean and negatively to the variance of price which is assumed to be exogenous. A reduction in price variance causes an outward shift in the supply curve which, they claim, increases the benefits to producers of stabilization. In the context of a commodity market with inelastic market demand, the result is quite different. The outward shift in supply caused by the aggregated responses of risk-averse firms will mean that greater certainty of output will be accompanied by lower expected revenues. Consequently, it is by no means obvious that the presence of risk aversion on the part of producers increases their welfare gain from stabilization.

In our model the existence of a floor price scheme increases the correlation of income between periods. As Gelb (1979) has emphasized, much of the variation is shifted into the lower frequencies. It appears to us to be very likely that producers would in fact be more averse to a low income realization if it follows one or more similarly low realizations. That is, the utility function is likely to violate the additivity assumption. The reason that this possibility is excluded from much risk analysis is not that it is unrealistic, but rather that it violates the axioms of Von Neuman-Morgenstern utility theory. (For more on this see Pollack (1967).) If utility is not intertemporally separable, the low-frequency fluctuations induced by a price floor could adversely affect producers.

It seems more reasonable, however, to relax the no-saving assumption, and model utility as a function of wealth rather than of net income. A deeper analysis must address the determination of land price in a market of risk-averse participants, and define the set of assets available for the producer's portfolio. These tasks will not be pursued here. But we conjecture that two general incidence conclusions continue to be valid: (1) the welfare effects on producers are capitalized and borne by current asset holders at the time of the policy change, and (2) these effects are more favorable to these landholders than indicated by the previous comparative statics analyses.

7. Conclusions

Floor price schemes and deficiency payments have quite different implications for market participants. If a floor price is set at a level below the free-market mean, the scheme will reduce the mean price in the long run for the usual convex demand curve. If the curvature of consumption demand (parameter C) is sufficiently high a price floor also reduces producer income and raises consumer surplus in the steady state. But the incidence effects under this condition depend on the level of the floor and the source of the market disturbance. A sufficiently high floor can substantially increase producer wealth (land plus commodity stocks) at the time of introduction, because the income-boosting effect of the early accumulation of public stocks dominates the negative long-run effects. Extra-market disposal is more efficient than a buffer stock as a means of achieving a given transfer to current holders of land and commodity stocks via a price floor.

But if the curvature of consumption demand is sufficiently low, a floor price scheme using a buffer stock will increase the wealth of those holding land and commodity stocks at the time of the (unanticipated) introduction of the scheme by more than the cost of its administration. This result is true for any effective floor below the mean price, and is consistent with the long run effect on producer incomes. At least for moderate levels of transfer, the floor price scheme supported by a buffer stock is more efficient than enforcement through extra-market disposal of the commodity, in contrast to cases with greater consumption demand curvature. The buffer stock scheme could be profitable as a private venture organized by an association of producers, even if it could not control output of the members.

A lower floor, or more elastic supply response, tends to reduce the positive dynamic effect on wealth and to favor consumers. A floor price scheme can also appear much more favorable to consumers, and less expensive, if private storage is ignored. Indeed, the standard analytical approach which neglects dynamic effects and private storage can so greatly bias results towards consumers that inferences about incidence effects can easily be reversed.

If the market disturbance is an exogenous shift in foreign excess demand, a floor price scheme with a buffer stock favors the source of instability at the expense of the domestic economy as a whole. From the domestic viewpoint, deficiency payments schemes are more efficient means of increasing wealth of current producers in this situation, provided that the welfare cost of budget finance is sufficiently low. But if supply is elastic, deficiency payments destabilize consumption by reducing the efficiency of the complementary interaction between production and storage. Like a price floor supported by extra-market disposal, but in contrast to a buffer stock scheme, deficiency payments waste resources by inducing a socially excessive mean long-run supply response.

All cases discussed share one common, elementary feature. The incidence on producers occurs only through capitalization of benefits as one-time changes in wealth, and is a purely dynamic phenomenon. In an agricultural sector which has a small share of the economy, price supports have no potential for altering the welfare of current producers in the long run, so conventional comparative statics studies are inappropriate for addressing the incidence question.

FOOTNOTES

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[2]For the implications of relaxing this assumption see Wright (1984).

[3]This is done implicitly in Wright and Williams (1984a), in which Figure V compares a market stabilized by private storage with an unstabilized market. In that case steady state producer revenues increase only if C is less than about 1.5. For 1.5 < C < 2, increased revenues are offset by costs of the storage. In the case of price floors, numerical results show that the expected steady state change in S^c is negative.

[4]If the supply disturbance is additive and refers to <u>domestic</u> production, responsive supply may mean less production and even greater gains in producer revenue, at the expense of consumers, than indicated in Propositions 3 and 5. By Proposition 3b, income of producers as a whole increases if C < 2 - K. Here the marginal incentive is the expected price, which by Proposition 4 falls for C > 0. Production contracts, increasing the producer income gains. More generally, aggregate supply responsiveness may favor producers as a group if their supply behavior is heterogeneous.

[5]Why assume risk neutrality on the part of private storers? The evidence indicates that any risk associated with commodity storage is eminently diversifiable (see Dusak (1973)), the comments of Carter, Rausser and Schmitz (1983), and the response of Marcus (1984)). Consistent with

this finding, empirical estimates find 'risk premia' in storage markets to be so small as to be difficult to detect at all.

[6] Why competitive storage? First, barriers to entry are insignificant. Second, monopolists would wish to store less than competitors in all 'states of the world' if they monopolize only storage (Wright and Williams 1984b), so free entry would drive them out. If a monopolist also controls production, Newbery (1984) has shown that the monopolist may store more than would a competitive market if demand is linear and price elastic in the relevant range. Thus the monopolist could drive out competitive storage. But here we are concerned with commodity markets in which consumption demand is almost invariably price inelastic. (If it is not, the role of storage tends to be negligible in models like ours. See Wright and Williams (1982a).)

[7] Previous investigations (Wright and Williams 1982a) have shown that the symmetry of the distribution can be important, but that a distribution like the one presented here gives results very similar to those for other compact symmetric distributions with the same variance, such as an 80 point discrete approximation to the normal distribution. Evidence on skewness of yields is sparse, and ambiguous with respect to the direction of skew. Hence we opt for symmetry as the best agnostic position.

[8] 'Land' is for simplicity defined here to include all fixed factors used in production of the commodity. Land is assumed to be owned by producers.

[9] This assumption is consistent with a general equilibrium

overlapping generations model with bequests (Calvo, Kotlikoff and Rodriquez (1979)). But if there are no bequests, the dynamic path of land price to the new steady state may not involve full Ricardian capitalization. In fact, in an overlapping generation context, under reasonable assumptions, full capitalization appears to be a limiting case. These dynamic general equilibrium issues have been investigated elsewhere in a non-stochastic context (Chamley and Wright 1983). Here we confine ourselves to the simpler Ricardian approach.

[10] Recent estimates of the marginal welfare cost of public finance (Stuart 1984 Table 2) tend to lie in the region 0.2 to 0.3, but for plausible parameterizations may well exceed 0.40. If we took this into account it is conceivable that the price floor scheme could involve a lower deadweight loss than an alternative deficiency payments scheme, especially if the commodity is, from an efficiency viewpoint, 'under-taxed' in the current fiscal structure.

[11] Indeed, if foreign (stochastic) excess demand were globally completely inelastic, then the optimal policy from the rational viewpoint would be to pay a price of zero to the foreign supplier when buying, and charge an infinite price when selling, a policy which amounts to a radical destabilization of border price. An interesting comparative statics model of market stabilization in an open economy is found in Tyers (1983).

Table 1

Comparative Statics Effects of Price Support Schemes[a]

	Consumer Price	Consumption	Consumer Surplus	Producer Surplus	Government Expenditure
1. Deficiency Payment Scheme					
1.1. $\eta^S = 0$	0 (0)	0 (0)	0 (0)	+ (-)	+ (+)
1.2. $\eta^S > 0$	- (+)	+ (+)	+ (+)	+ (+)	+ (+)
2. Floor Price Scheme					
A. Multiplicative Production Disturbance Shared by All Producers:					
2.1. $\eta^S = 0$	Sgn(C) (-)	0 (-)	Sgn(C-1) (-)	Sgn(2-C-K) (-)	+ (-)
2.2. $\eta^S > 0$	Sgn(C) (-)	Sgn(2-C-K) (-)	? (-)	Sgn(2-C-K) (-)	+ (+)
B. Stochastic Export Demand, Mean Zero:					
2.3. $\eta^S = 0$	Sgn(C) (-)	0 (-)	Sgn(C-1) (-)	Sgn(C) (-)	+ (+)
2.4 $\eta^S > 0$	Sgn(C) (-)	- (-)	? (-)	Sgn(C) (-)	+ (+)

[a]Signs of the directions of changes of means, and, in parentheses, standard deviations, are shown in the table. $C \equiv -q(\partial^2 P/\partial q^2)/(\partial P/\partial q)$ and K is a function of the change in private storage costs, as described in the text.

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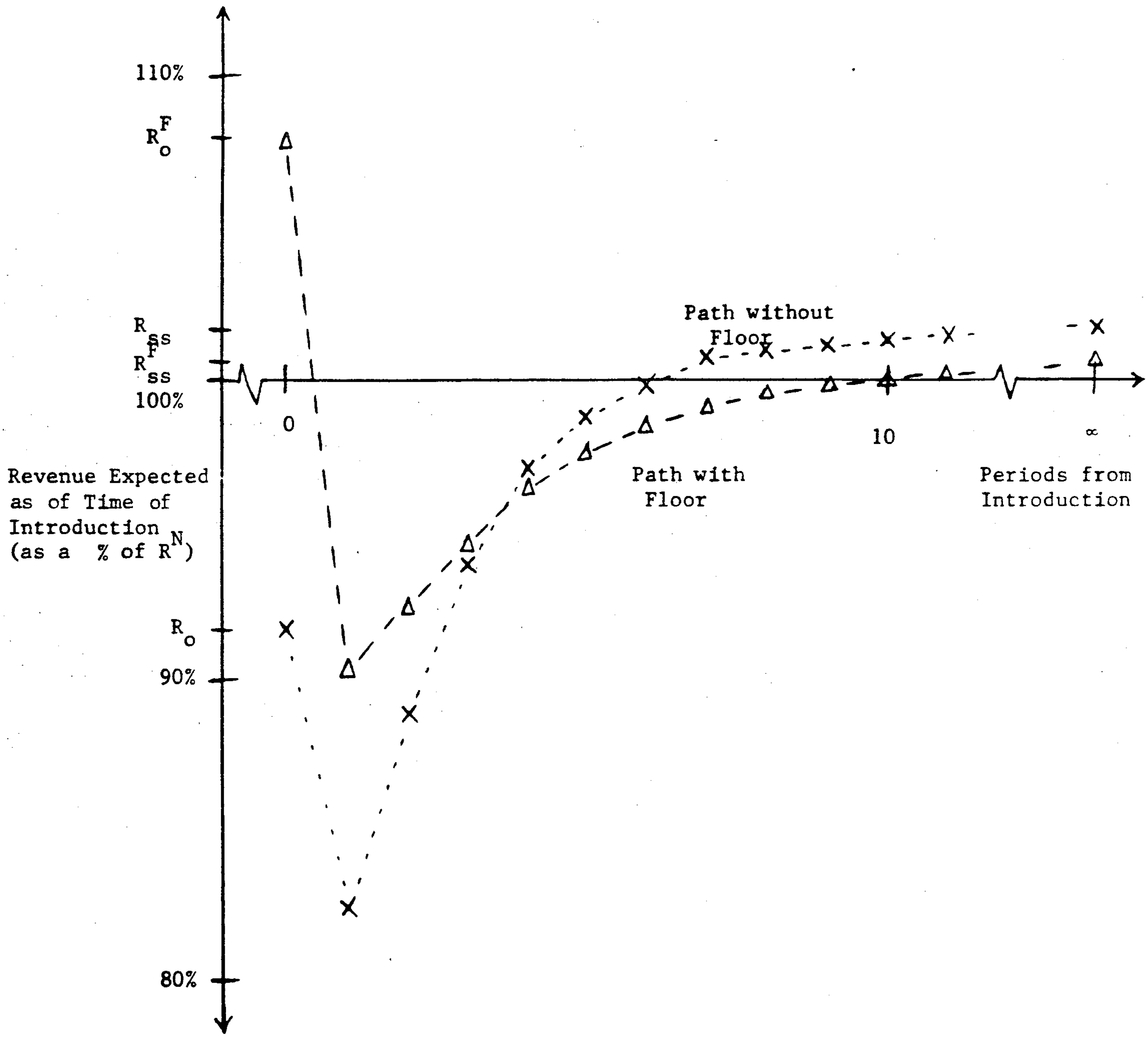


FIGURE 1

EFFECT OF A PRICE FLOOR

ON THE EXPECTED TIME PATH OF REVENUE

($\eta^D = -0.2$, $C = 6$, $\eta^S = 0.0$, Floor = 90% of P^N)

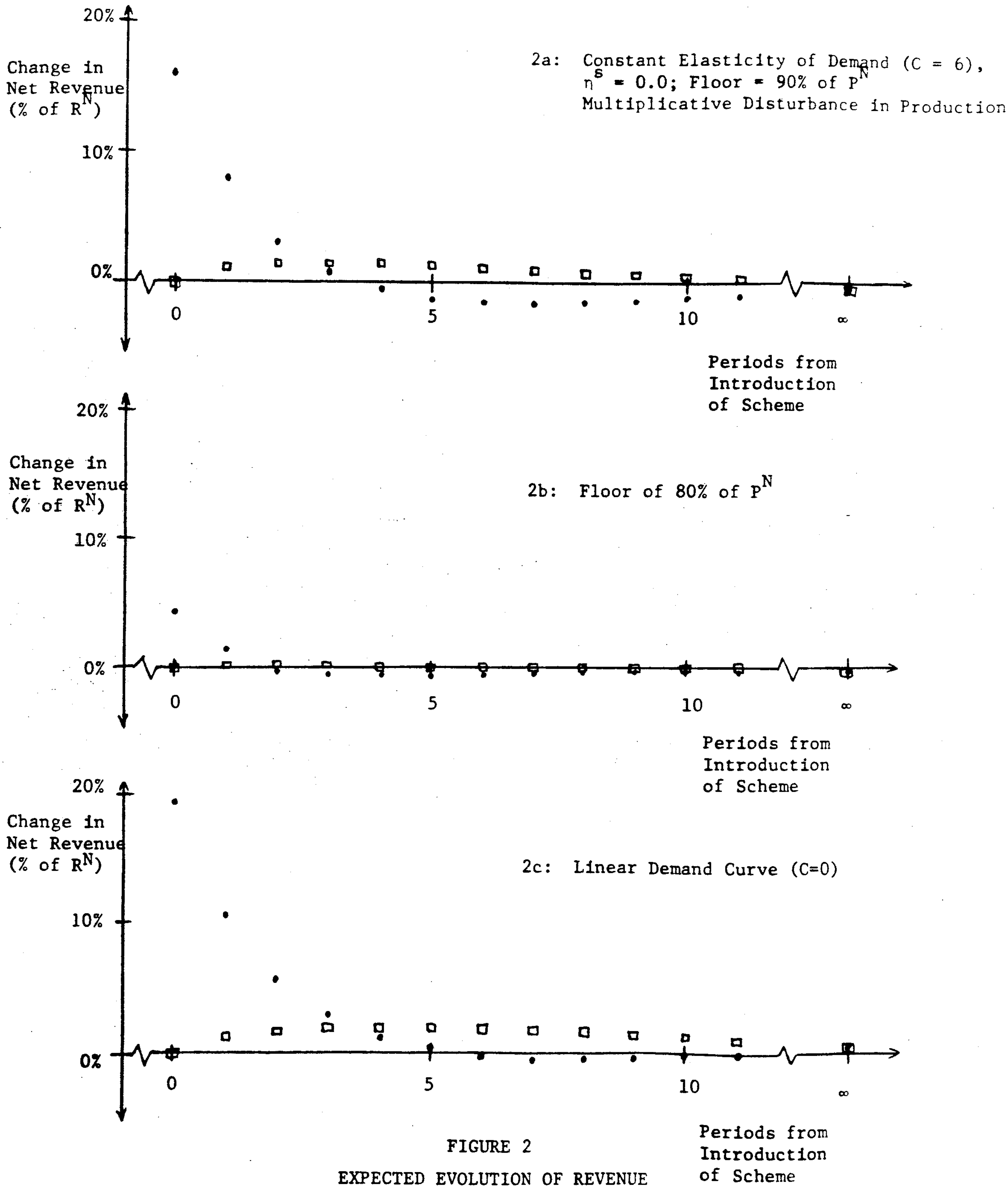


FIGURE 2

EXPECTED EVOLUTION OF REVENUE AS OF INTRODUCTION OF SCHEME

• High Initial Availability

□ Low Initial Availability

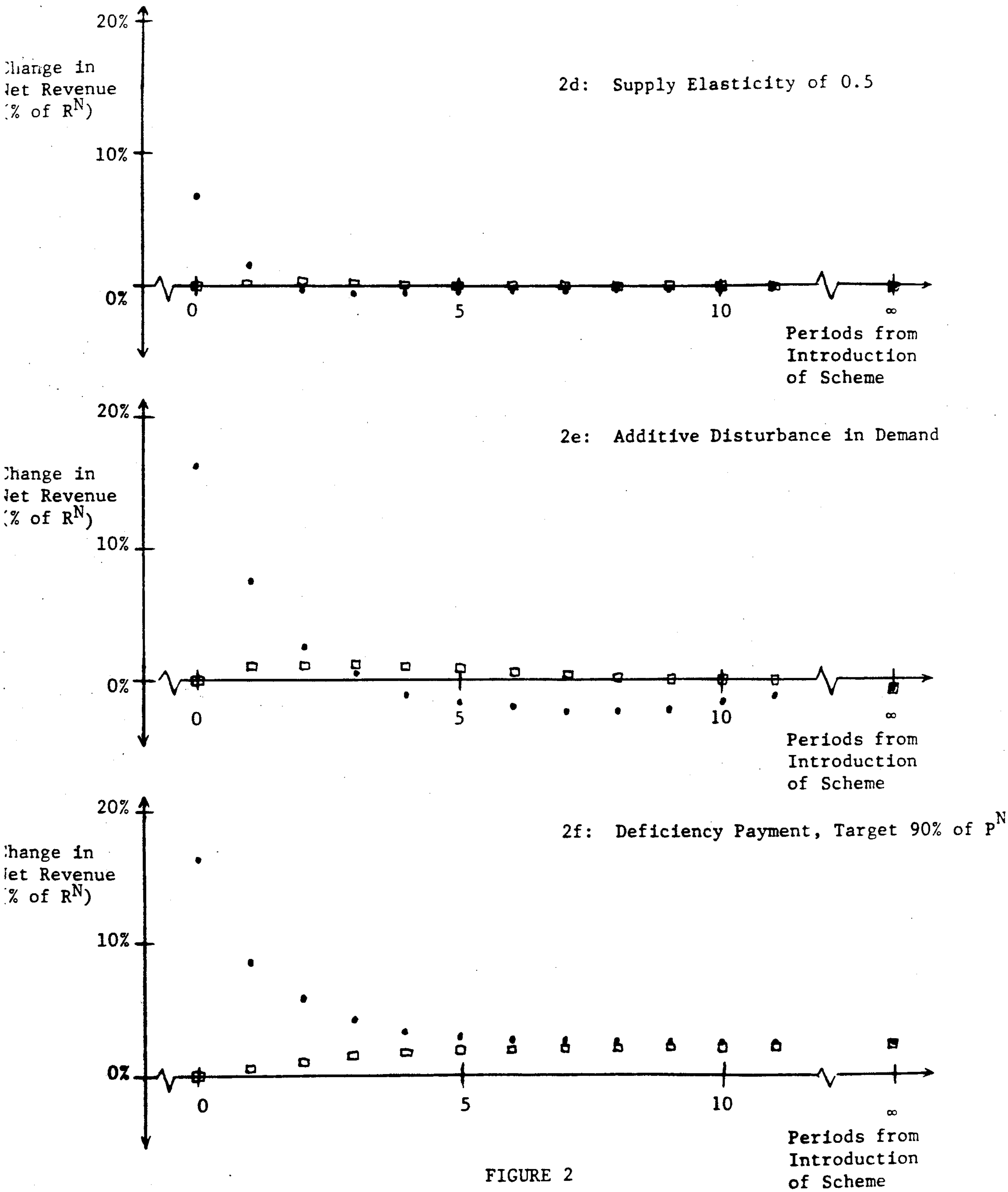


FIGURE 2

EXPECTED EVOLUTION OF REVENUE
AS OF INTRODUCTION OF SCHEME

• High Initial Availability

□ Low Initial Availability

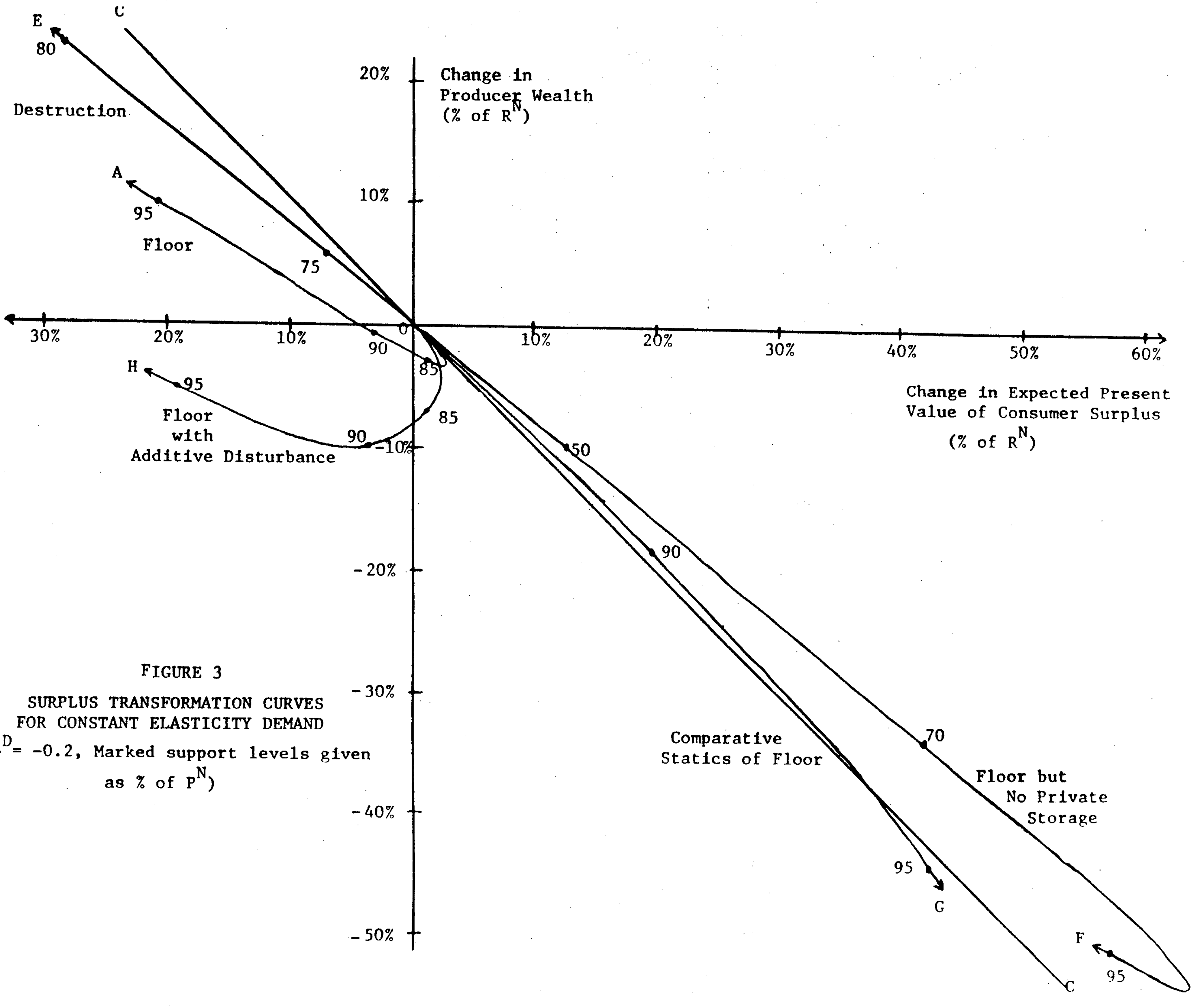


FIGURE 3

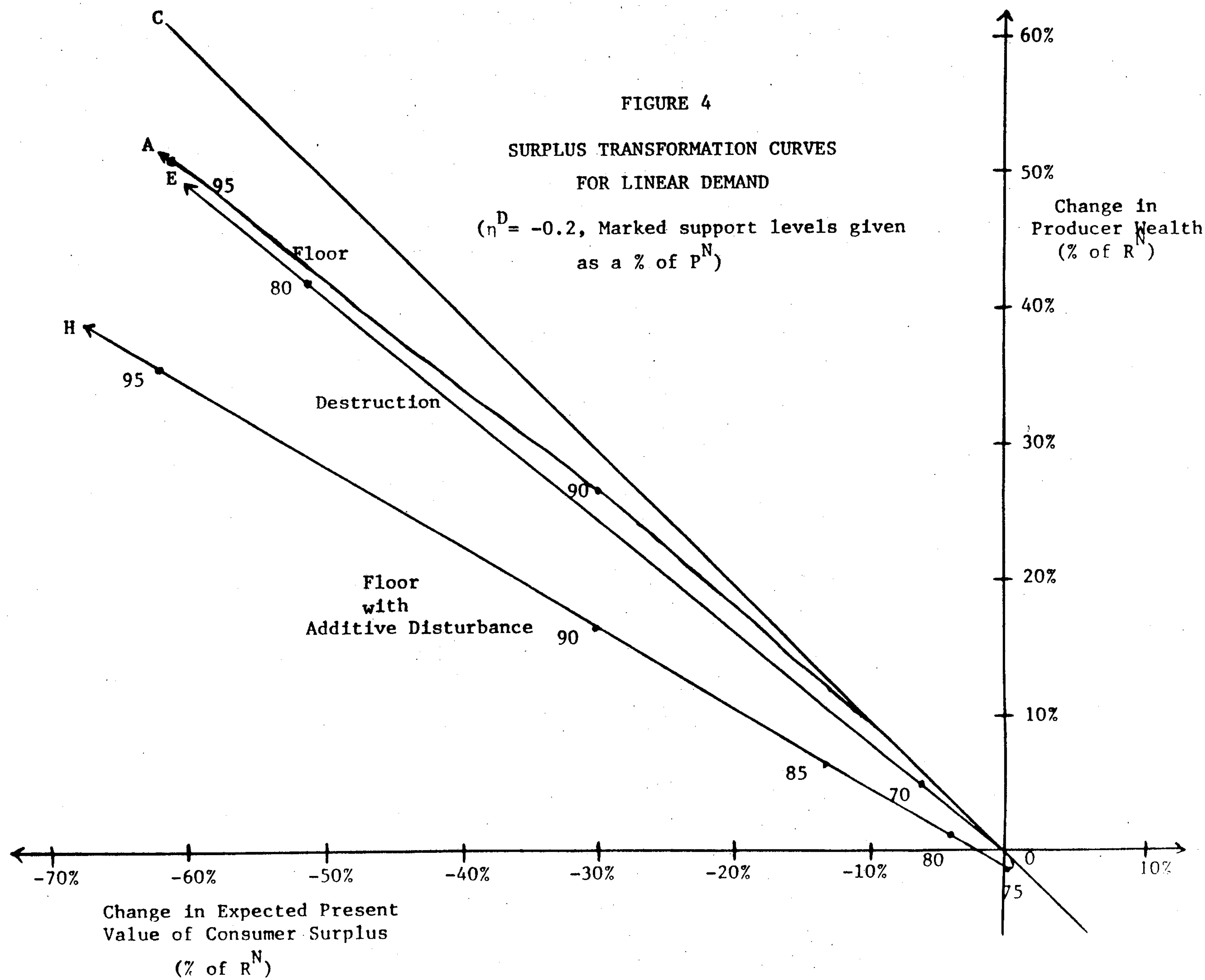
SURPLUS TRANSFORMATION CURVES
FOR CONSTANT ELASTICITY DEMAND
($\eta^D = -0.2$, Marked support levels given
as % of P^N)

FIGURE 4

SURPLUS TRANSFORMATION CURVES

FOR LINEAR DEMAND

($\eta^D = -0.2$, Marked support levels given as a % of P^N)



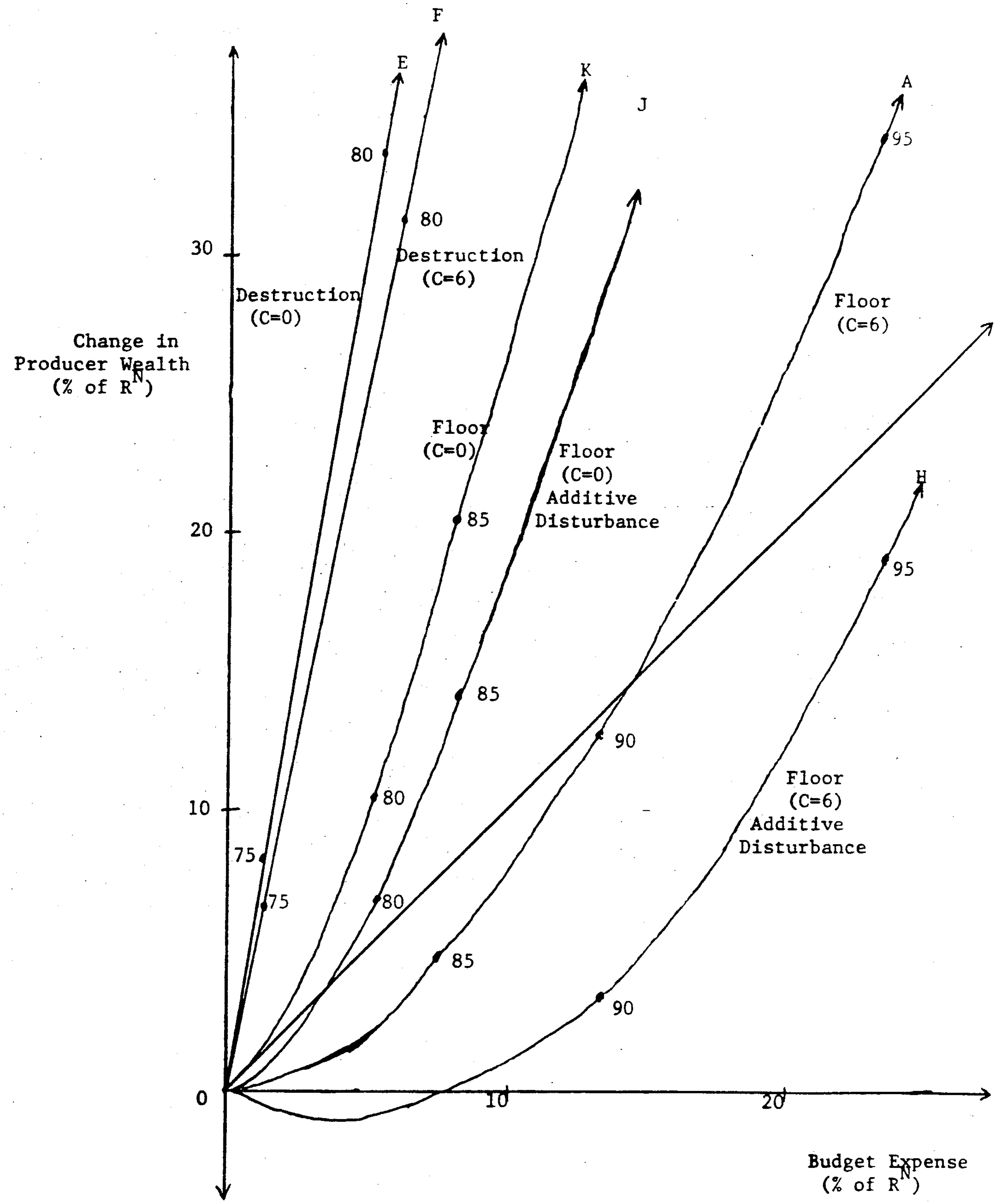


FIGURE 5

BUDGET EFFICIENCY OF THE

WELFARE TRANSFER

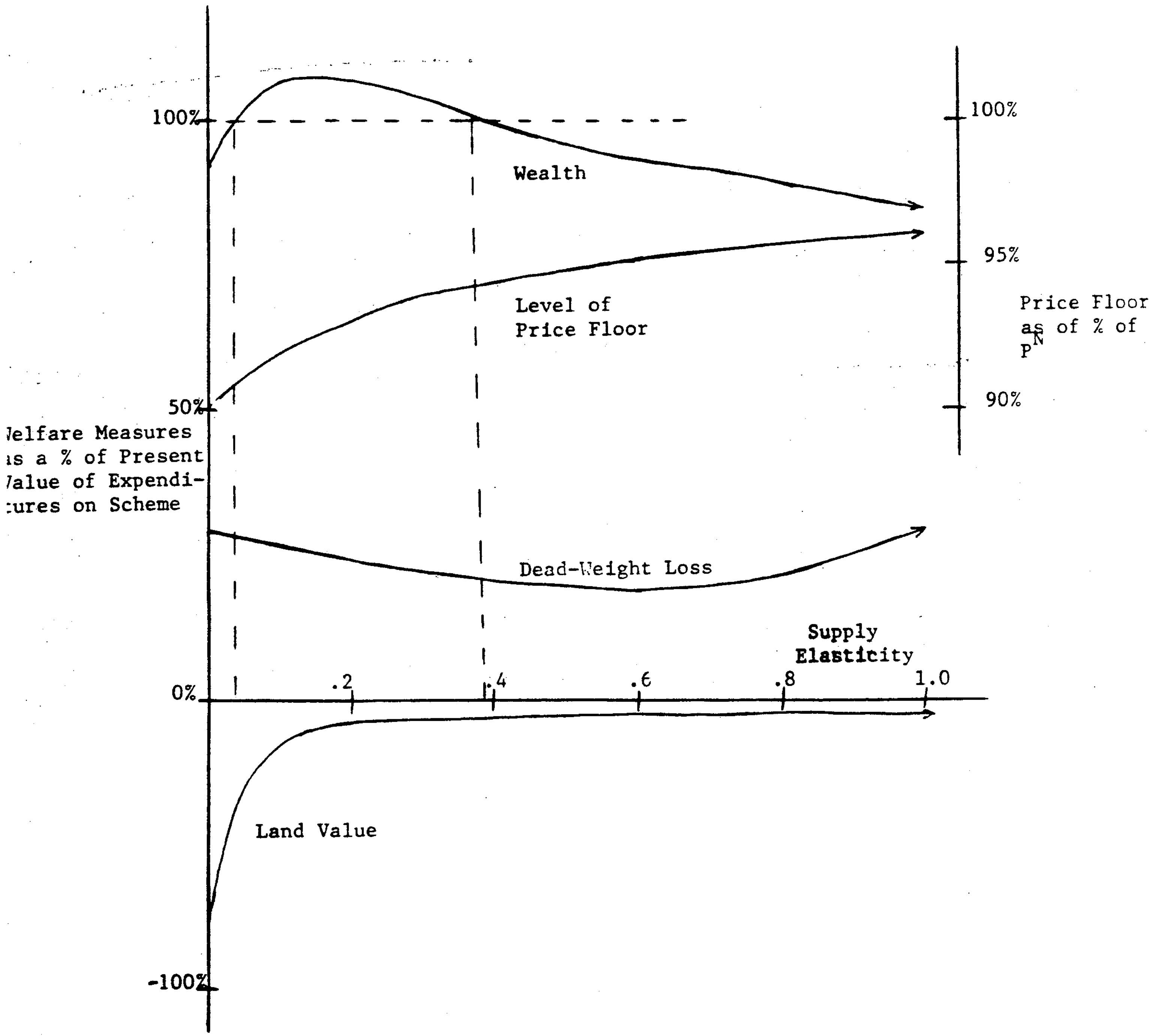


FIGURE 6

EFFECT OF RESPONSIVE SUPPLY

HOLDING EXPENDITURES CONSTANT

($\eta^D = -0.2$, $C = 6$, $A_0 = 120\%$ of q^N)