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NOTCHES

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ABSTRACT

Economists have an instinctively negative reaction to any government program that creates a "notch," that is, a discontinuity in a budget constraint. For example, welfare programs like public housing are structured so that a finite lump of benefits is lost all at once when a household's income crosses a certain threshhold. Such notches deserve their bad reputation -- they effectively impose a high marginal tax rate over a small income range, which no doubt discourages work and promotes welfare dependency.

However, this paper argues that in other contexts, tax and subsidy plans with notches should at least be considered as serious contenders when public policy seeks to encourage or discourage some activity. Using simulations, we show how notch schemes can dominate traditional linear schemes using a standard efficiency criterion.

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I. Introduction

Tax and transfer systems provide numerous incentives that influence people's behavior. Sometimes, these incentives are inadvertent by-products of the need to raise revenue. Other times, public policy deliberately aims to change behavior. In either case, the approach typically favored by economists is to change the slope of some relevant budget constraint by introducing a tax or a subsidy. A Pigouvian emissions fee is a clear example.

Economists have an instinctively negative reaction to any program that creates a "notch," that is, a discontinuity in a budget constraint. Perhaps the best known example of a notch comes in the welfare system, where such programs as Medicaid and public housing are structured so that a finite lump of benefits is lost all at once when a household's income crosses a certain threshhold. The reason for economists' negative attitudes toward this notch is clear: for people with low earnings potential, the notch effectively imposes a very high marginal tax rate over a small income range, which no doubt discourages work and promotes welfare dependency.

Such notches deserve their bad reputations. However, this paper argues that in other contexts tax and subsidy plans with notches may have been dismissed too cavalierly, and should at least be considered as serious contenders when public policy seeks to encourage or discourage some activity. Since this idea is so foreign to our normal way of thinking, perhaps we should develop the intuition behind it at the outset.[1]

A standard tax or subsidy alters the relative price that everyone faces, and hence distorts everyone's behavior. A notch, on the other hand, leaves the effective price unchanged -- except, of course, at the notch, where the price is undefined. Consequently, a standard tax or subsidy imposes small excess burdens on everyone, while a notch imposes large excess burdens on a small number of people. Stated this way, it is not immediately obvious that the notch approach is always inferior. Indeed, this paper produces several examples in which notches are clearly superior.

Although notches have a bad name among economists, they are not uncommon in the private sector. Some airlines stimulate the demand for air travel not by lowering the price per ticket, but by offering a free ticket for passengers who have flown more than a certain number of miles. Similarly, banks and savings and loan associations occasionally attempt to increase deposits not by offering a higher rate of interest, but by awarding a "gift" to customers who deposit an amount exceeding some specified level. This paper argues that notches may sometimes be appropriate in the public sector as well.

The paper is organized as follows. Section II uses a simple example -- the tax deductibility of charitable contributions -- to explain the basic ideas, develop a methodology for addressing the issue, and then compare the relative efficacy of notches versus traditional linear subsidies in stimulating charitable giving. We conclude that a notch incentive may dominate a traditional linear incentive. Some practical problems involved in implementing notch incentives are discussed in Section III, and Section IV contains some concluding remarks.

II. Stimulating Demand for a Commodity

Suppose the government wants to stimulate one person's charitable giving, which we denote in Figure I by F (for "favored" commodity). If the person's marginal tax rate is t, deductibility of charitable contributions lowers the effective price of each dollar of charity from \$1 to \$(1-t), thereby pivoting the budget constraint between F and all other goods from MN out to MO. As a consequence, the individual's optimum moves from E_1 to E_2; charitable giving winds up at F_2.

The government could induce an identical increase in charity by the following notch system: if the individual donates F_2 or more, he receives a lump sum subsidy equal to DE_2; otherwise, he receives nothing. The budget constraint associated with this notch scheme is MDE_2H, and the optimum choice remains E_2. Thus the notch and linear schemes have exactly the same revenue cost, DE_2, and induce the same behavior. This discussion illustrates an obvious point. As long as only one individual is being considered -- or equivalently, if it is possible to design a separate notch scheme for each individual -- then there is nothing to choose between a linear incentive and a notch incentive. However, in the realistic case in which individuals

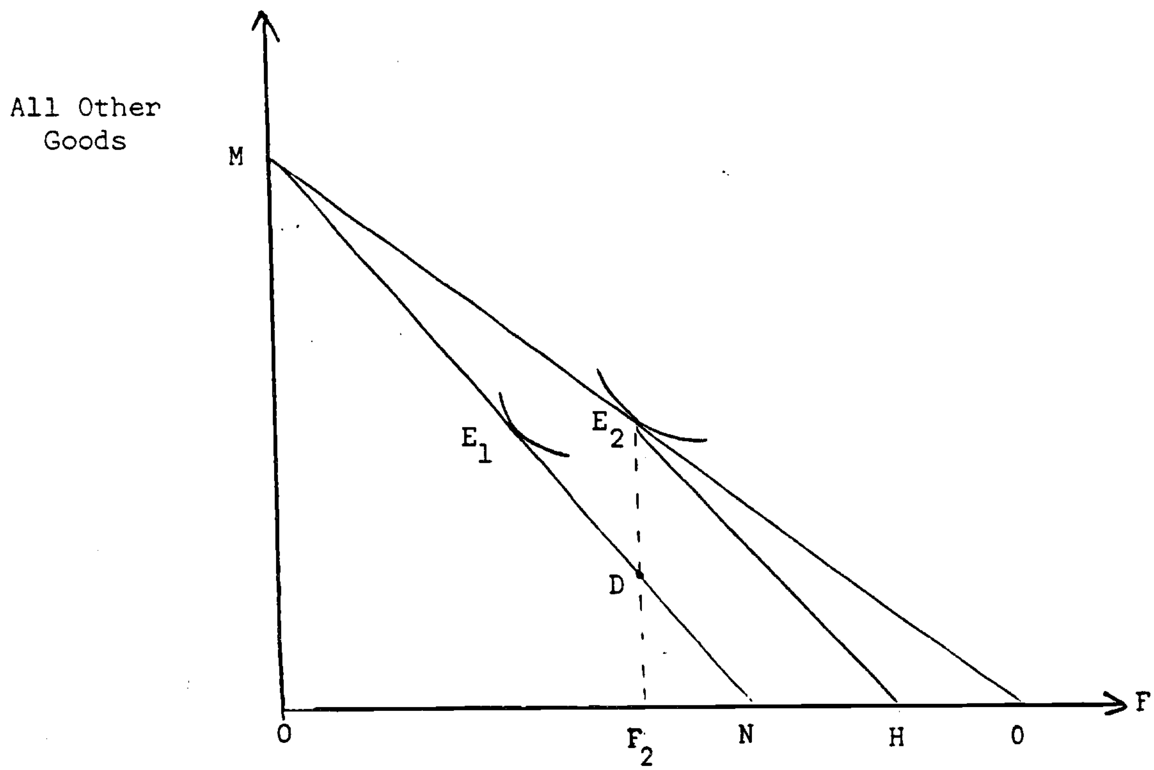

Figure I

have heterogeneous tastes, and all taxpayers (at least within the same income class) face the same budget constraint, then the notch and linear subsidy schemes can have quite different implications.

To see why, consider Figure II. Under the status quo, individuals A, B, and C all face budget constraint MN. Individual A's highest attainable indifference curve is labelled U_A, and similarly for B and C. Now suppose that a notch subsidy of G is granted to anyone who donates at least F*. The budget line confronting all three individuals becomes MDKI. As seen in the diagram, individual A's behavior is unchanged. Individual C moves up to indifference curve U'_C. Note that the movement from U_C to U'_C induced by the subsidy creates no excess burden -- it is equivalent to a lump sum grant. Now consider individual B. His best choice under the notch subsidy is right at the notch (indifference curve U'_B). In contrast to C, the subsidy to B does create an excess burden. Individual B would be better off with a lump sum subsidy of G, which would produce budget constraint HI, allowing B a utility level U''_B which exceeds U'_B.

Thus, as we stated in the introduction, under a notch scheme, some individuals face no excess burdens, and some face large ones. The aggregate excess burden depends on the distribution of individual tastes. Generally, the more people that behave like B, the higher will be the total excess burden under a notch. The revenue costs of notch subsidies similarly depend on the distribution of tastes.

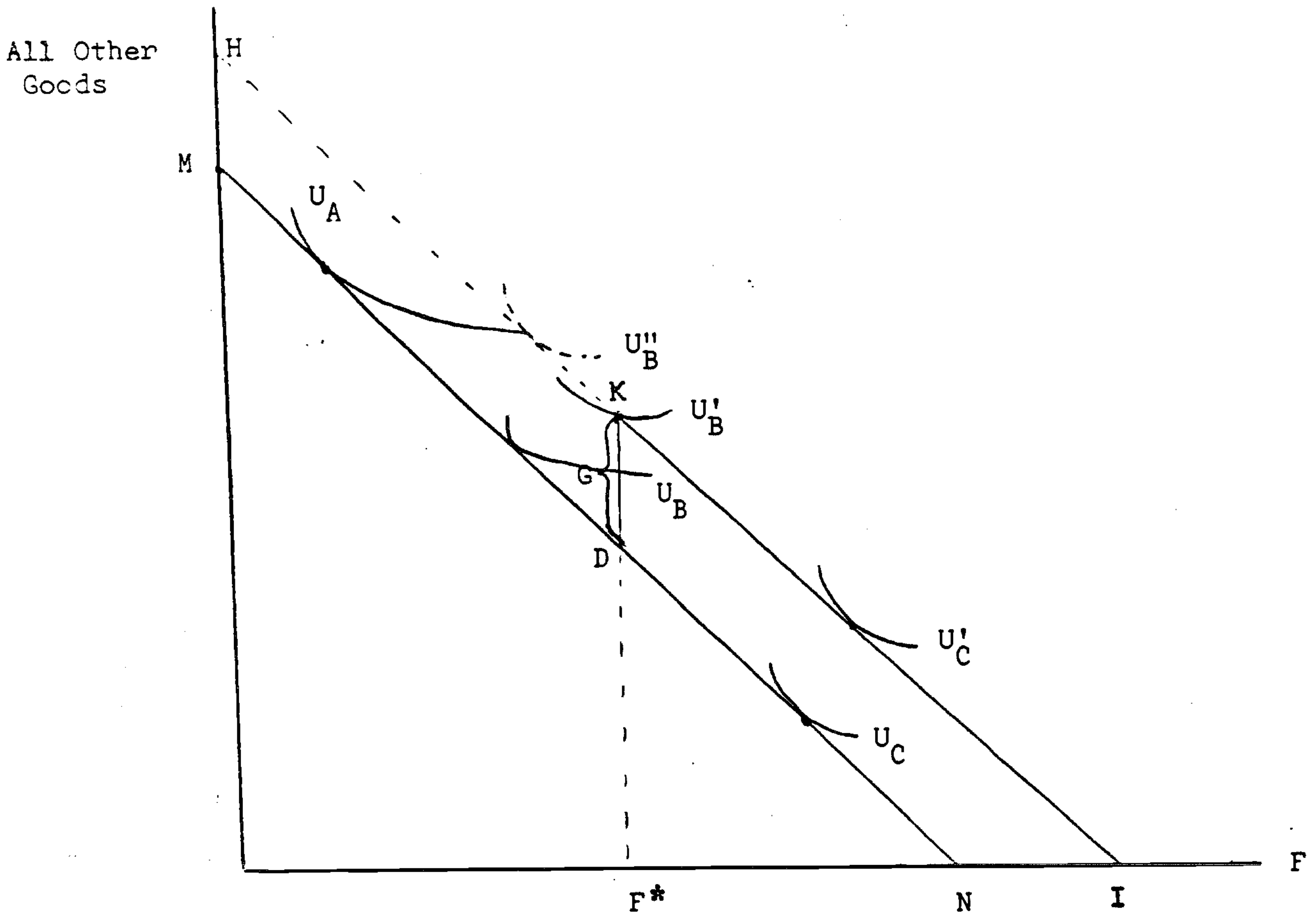

Figure II

Can it be that the notch scheme is preferable to a conventional linear subsidy? Because heterogeneity of the population is the essence of the matter, it is difficult to obtain an analytical answer even for very simple assumptions about utility functions and the joint distribution of their parameters. For this reason, we rely on simulation techniques. Our strategy is to posit specific utility functions and numerical distributions of their parameters, and investigate the relative desirability of notch and linear incentives under alternative assumptions.

II.1 Basic Set-Up

Let an individual's utility level, U, depend on his consumption of a composite commodity, Y, whose price is equal to unity, and F, the favored commodity. Suppose the utility function is of the constant elasticity of substitution form:

$$(1) \quad U = [aF^{-b} + (1-a)Y^{-b}]^{-1/b}, \qquad b > -1,$$

where a and b are taste parameters, and the elasticity of substitution is given by $\sigma = 1/(1+b)$. With a linear subsidy at rate s, the individual's budget constraint is:

$$(2) \quad (1-s)P_F F + Y = M + Z ,$$

where P_F is the price of the favored good, M is income, and Z is any lump sum transfers (positive or negative) from the government.

Maximizing utility subject to constraint (2) leads to the following demand functions:

$$(3)\quad F = \frac{M+Z}{(1-s)P_F + K((1-s)P_F)^{\sigma}},$$

$$(4)\quad Y = \frac{K(M+Z)}{K + ((1-s)P_F)^{1-\sigma}},$$

where $K = [(1-a)/a]^{\sigma}$. Note that since the utility function is homothetic, the Engels' curves are rays through the origin as long as Z is proportional to M. Thus, any results that apply to one income level can be scaled up or down to apply to other income levels.

It will be useful to have a formula for the indirect utility function, which turns out to be:

$$(5)\quad V = \left(\frac{M+Z}{Q(s)}\right) [A(s)]^{-1/b},$$

where $A(s) = a + (1-a)[K(1-s)^{\sigma}P_F^{\sigma}]^{-b}$

and

$Q(s) = (1-s)P_F + K[(1-s)P_F]^{\sigma}$.

II.2 Analysis of a Linear Subsidy.

We turn first to the efficiency and revenue consequences of a linear subsidy. To compute the subsidy's excess burden, we must find the monetary value of the difference between the utility level achieved by the subsidy, and the level that would have been achieved had the subsidy been given as a lump sum. Thus, note that the cost to the treasury for a given individual is sFP_F. Suppose that sFP_F had been given to the individual as a lump sum, without distorting relative prices. Then, using equation (5), utility would be:

$$(6) \quad V_0 = \left(\frac{M + sFP_F}{Q(0)}\right) [A(0)]^{-1/b}.$$

As is well known, in the absence of other distortions, a price-distorting subsidy raises utility by less than a lump sum subsidy of the same amount. If V_0 is the utility level with the lump sum, and V_L is utility with the linear subsidy, then we define the excess burden of the subsidy as the amount of money we would have to take away from the individual at V_0 to lower his utility to V_L.[2] Algebraically, the excess burden, B_L, is implicitly defined by:

$$\left[\frac{M}{Q(s)}\right] A(s)^{-1/b} = \left[\frac{M+sFP_F-B_L}{Q(0)}\right] A(0)^{-1/b} ,$$

which has the closed-form solution

$$B_L = M\left[1 + \frac{sP_F}{Q(s)} - \frac{Q(0)}{Q(s)}\left(\frac{A(s)}{A(0)}\right)^{-1/b}\right] .$$

The aggregate excess burden of the linear subsidy is simply the sum of B_L across the individuals, and the total cost to the treasury is the sum of sP_FF.

II.3 Analysis of a Notch Subsidy

Now consider a scheme which awards a lump sum subsidy of G to individuals who donate at least some critical amount F*, and zero otherwise. In calculating the excess burden of the notch subsidy, three possibilities must be considered.

(a) The individual's optimal decision is unchanged. In this case, there is no excess burden and no budgetary cost. This case corresponds to individual A in Figure II.

(b) The individual is induced to consume right at the notch. Here the cost of the subsidy is clearly G per individual. There is also an excess burden, which corresponds to the difference between utility levels U''_B and U'_B in Figure II. To find the individual's utility level at the notch, we must evaluate the direct utility function[3] at $F = F^*$ and $Y = M + G - P_FF^*$, yielding:

$$V_N = [a(F^*)^{-b} + (1-a)(M + G - P_FF^*)^{-b}]^{-1/b} .$$

Following the reasoning behind equation (6), the utility if the same subsidy had been granted as a lump sum is:

$$[\frac{M + G}{Q(0)}]A(0)^{-1/b}.$$

Hence, the excess burden for such an individual, B_N, is implicitly defined by:

$$a(F^*)^{-b} + (1-a)(M + G - P_F F^*)^{-b} = \left[\frac{M + G - B_N}{Q(0)}\right]^{-b} A(0)$$

or explicitly by:

$$(7)\quad B_N = M + G - Q(0)\left\{\frac{a(F^*)^{-b} + (1-a)(M + G - P_F F^*)^{-b}}{A(0)}\right\}^{-1/b}$$

(c) The individual consumes more than the critical quantity F* after the notch scheme is imposed. In this case, the notch subsidy is equivalent to a lump sum transfer, so again there is no excess burden. But there is a cost to the treasury, namely G. This corresponds to individual C in Figure II.

To summarize: If there are n_a individuals in category (a), n_b in category (b), and n_c in category (c), then the total cost of the notch subsidy is $(n_b + n_c)G$, and the total excess burden is the sum of B_N defined by equation (7) across the individuals in category (b).

II.4 Simulation Strategy

The simulations assume a population of 499 people. Individuals are indexed by their value of a, the share parameter in the utility function. The values of a are distributed uniformly between 0.0002 and 0.0998.[4] Within each simulation, the elasticity of substitution is the same for all individuals. But its value is varied across simulations. The units of F are chosen to make P_F, its before-tax price, equal to one. Each person's income, M, is also normalized to 1. Thus the simulations should be thought of as applying to a given income class. Since our utility functions are homothetic, this is not a substantive restriction.

We first compute aggregate demand for F in the absence of any subsidies. Then we impose a linear subsidy of 20% (s = 0.2), and compute the amount by which consumption of F is stimulated, the revenue cost to the government, and the total excess burden. Next, we turn to the notch subsidy, and search over various combinations of G and F* to find those that yield the same total demand for F. In general, an infinite number of notch schemes are consistent with any fixed value of aggregate F. For example, if F* is set very high, but at the same time G is large, it might be possible to achieve the same aggregate value of F as when both parameters are low. Criteria for choosing among the various notch schemes are discussed below.

II.5 A Cobb-Douglas Result

We begin by discussing the Cobb-Douglas case.[5] Column 1 of Table I shows that the aggregate consumption of the favored good in the absence of any subsidy is 24.3 units. Column 2 indicates that imposition of a 20% subsidy increases the quantity demanded to 30.5.[6] The cost to the treasury of the subsidy is 6.1, and the associated excess burden is 0.62. Thus the subsidy is

Table I

Subsidy to Consumption of a Commodity
Cobb-Douglas Utility Functions
Uniform Distribution of a

	(1) Status Quo	(2) Linear Subsidy s=0.2	(3) Notch Subsidy (a) F*= .03 G = .164	(4) Notch Subsidy (b) F*= 0.183 G = 0.035	(5) Notch Subsidy (c) F*= 0.116 G = 0.015
Total Demand for F	24.3	30.5	30.5	30.5	30.5
Total Revenue Cost	0	6.1	81.9	2.4	2.6
Total Excess Burden	0	0.62	1.04	2.0	1.19
TEC (m=0.2)	0	1.8	17.4	2.5	1.7
TEC (m=0.4)	0	3.1	33.8	3.0	2.2

relatively efficient in this case: the deadweight loss per dollar of subsidy is only about 10 cents.[7] This is worth pointing out, because it shows that the simulation is set up to make the linear subsidy scheme hard to beat.

Our next goal is to devise a notch scheme that induces the same change in behavior, and compute its revenue cost and excess burden. As just noted, an infinite number of notch schemes can do the trick. Columns 3, 4, and 5 compare three possibilities.

In column 3 (notch subsidy (a)), the notch is set at a relatively low level of consumption, F* = .03 units, which is about half the mean consumption level under the linear subsidy. With F* set this low, we must induce essentially everyone in the population to donate at least F* in order to reach the target for aggregate donations. And, to accomplish this, a large grant of G = .164 (16.4% of total income) is required. The revenue costs of setting F* at such a low level are revealed in the second row: the cost to the treasury is 81.9, about thirteen times greater than the cost of the linear subsidy. The excess burden of 1.04 also far exceeds that of the linear subsidy. It is clear that notch subsidy (a) is a perfectly dreadful idea.

Under notch subsidy (b) in column 4, the notch is set at a very high value, 0.183, or 18.3% of income. This is about three times the average consumption level under the linear subsidy. With required consumption so high, most people do not take advantage of the subsidy; only 15% receive the grant of 0.035. As a consequence, the revenue cost is far lower than under the linear subsidy, only 2.4. However, those people who do accept the subsidy have their behavior distorted considerably; the excess burden is 2.0, more than triple the excess burden under the linear subsidy.

A final possibility, notch subsidy (c), is exhibited in column 5 of Table I. The notch is placed at a lower level than in column 4 but a higher level than in column 3: $F^* = .116$. The revenue cost is higher than in column 4, but the excess burden is lower. This is because the people whose behavior changes are nearer the notch, and hence their decisions are less distorted.

The results in Table I taken together suggest that while some notch incentives (such as notch subsidy (a)) will do quite horribly compared to linear schemes, others will do quite well. Both schemes (b) and (c), although they have higher excess burdens than the linear subsidy, have much lower revenue costs. On balance, therefore, they might be preferable.

This observation leads to an important question: Given that we are judging subsidy systems on the basis of two criteria, revenue cost and excess burden, how are we to compare them when one is better on one criterion and the second on the other? There are two possibilities:

(1) The most natural approach is to compare the schemes on the basis of what we call total efficiency cost (TEC), defined as the sum of the excess burden arising from distorting the demand for the favored good plus the efficiency cost of raising the revenues needed to finance the subsidy. If taxes were lump sum,

the efficiency cost of replacing the revenue lost by the subsidy would be zero, and the TEC would just be the standard excess burden of the subsidy. However, real world tax finance creates its own efficiency costs. If m is the marginal excess burden created by a dollar of taxes raised in the private sector, then the TEC is just m times the revenue loss plus the excess burden from distorting the consumption of F.

What is the value of m? The answer depends on what tax instrument the government uses, and the supply and demand elasticities of the item(s) being taxed. Traditionally, the marginal excess burden of taxation has been supposed to be quite low--practically zero. Recent estimates are higher. Ballard, Shoven and Whalley (1982) estimate that the marginal excess burden of a dollar raised via the corporate tax is about $0.50. This is the same as the estimate obtained by Stuart (1984) for the whole tax system. Hausman's (1981) econometric study of labor supply suggests that if a dollar is raised by a tax on labor income, the marginal excess burden is about $0.42. In the absence of agreement on what the marginal excess burden of taxation is, it makes no sense to restrict ourselves to one figure. We therefore do calculations assuming values of m of both 0.2 and 0.4 which, if anything, seem on the low side.[8]

The TEC figures are recorded in the fourth and fifth rows of Table I. Assuming m = 0.2, notch subsidy (b) with a TEC of 2.5, is inferior to the linear subsidy, whose score is 1.8. However, notch subsidy (c), with a TEC of 1.7, is better than the linear subsidy. In fact, when m = 0.2, notch subsidy (c) is the most efficient of all possible notch subsidies in the sense of having the minimum TEC. When m = 0.4, both notch schemes (b) and (c) are better than the linear subsidy.

These results suggest that the outcome depends critically on the assumed value of m. The reason is clear. Reasonable notch schemes make smaller demands on the treasury than linear schemes, but often have larger excess burdens. If m is high, a great deal of weight is given to the smaller revenue cost, thereby enhancing the attractiveness of notch schemes. If m is low, the excess burden is relatively more important -- which enhances the attractiveness of linear schemes.

(2) The second way to compare various subsidy programs questions the relevance of excess burden in this context. After all, the whole exercise of measuring excess burden assumes that the subsidy "distorts" behavior away from the optimum. This might, of course, be the case if the subsidy was instituted solely in response to political pressures. On the other hand, it is possible that the subsidy is deliberately put in place to correct an externality.[9] As is well known, a subsidy levied on a good that generates positive externalities might actually enhance efficiency, that is, have a negative excess burden. In this case, the standard excess burden calculation does not really make sense.

This discussion leads to the following conclusion. In some instances, it may make more sense simply to look at the budgetary cost of achieving the required increase in consumption of the favored good, making no allowance for excess burden. And a glance at Table I indicates that if minimizing revenue cost is the sole criterion, a well-chosen notch scheme may well be superior to a linear subsidy.[10] By targetting the subsidy to those whose tastes for the favored commodity are relatively intense, the notch subsidy does not "waste" money on those whose consumption is not stimulated very much.

On the basis of Table I, then, we conclude that notch subsidies may be better than linear subsidies. This is more likely to be true when the distortion that arises is not considered to generate a deadweight burden, or when a relatively high weight is put on the efficiency costs of financing revenue losses. But it can also be true in other cases.

II.6 Changing the Elasticity of Substitution

How does the relative attractiveness of linear and notch subsidies depend upon the elasticity of substitution between the favored commodity and all other goods? To answer this question, we repeated the simulation assuming $\sigma = 0.5$ and $\sigma = 1.5$. The results are reported in Table II. In each case, we:

(i) compute consumption of the favored good in the absence of any subsidy (columns 1 and 4);

(ii) compute consumption, revenue cost, and excess burden associated with a 20% linear subsidy (columns 2 and 5);

(iii) use numerical methods to find the best notch subsidy

Table II

Subsidy to Consumption of a Commodity
Alternative Elasticities of Substitution
Uniform Distribution of a

	$\sigma = 0.5$			$\sigma = 1.5$		
	(1) Status Quo	(2) Linear Subsidy s = 0.2	(3) Notch Subsidy F*= 0.28 G = 0.03	(4) Status Quo	(5) Linear Subsidy s = 0.2	(6) Notch Subsidy F*= .04 G = .007
Total Demand for F	87.4	99.7	99.7	6.90	9.62	9.62
Total Revenue Cost	0	19.9	6.4	0	1.92	0.95
Total Excess Burden	0	.92	2.80	0	0.29	0.51
TEC (m=0.2)	0	4.90	4.09	0	0.68	0.70
TEC (m=0.4)	0	8.89	5.37	0	1.06	0.89

that induces the same amount of consumption as the linear subsidy, where "best" means that the TEC is at a minimum for m = 0.2.[11]

When σ = 0.5, the notch subsidy has an excess burden about three times that of the linear subsidy, but a revenue cost less than one third as large. This pattern is already familiar from the Cobb-Douglas case examined in Table I. If we consider revenue costs alone, the notch scheme is certainly superior by a wide margin. If we consider both excess burden and efficiency costs, and assume m = 0.2, we find that the TEC for the notch scheme (4.09) is about 17% smaller than that of the linear scheme (4.90). In the Cobb-Douglas case of Table I, the comparable improvement was only about 8%. This suggests that the attractiveness of the notch subsidy is enhanced when the elasticity of substitution decreases.

This impression is confirmed when we examine the results for σ = 1.5 reported in the right side of Table II. When σ = 1.5, the total efficiency cost of the notch subsidy when m = 0.2 slightly <u>exceeds</u> that for the linear subsidy. To be sure, the notch scheme is still much cheaper, but this is not enough to counter its deficiency on the excess burden criterion when m = 0.2. However, when m = 0.4, the notch scheme is preferred to the linear scheme even with σ = 1.5.

The explanation for these results lies in the fact that low values of σ translate into low price elasticities of demand for F. Thus, relatively large values of the linear subsidy rate are required in order to achieve any given change in the demand for F. For example, Table II shows that with $\sigma = 0.5$, a 20% subsidy raises consumption only 14%. Because the linear subsidy works entirely via price effects, low elasticities of substitution make the linear subsidy more expensive.

On the other hand, the notch subsidy achieves much of its stimulus through income effects and, with a CES utility function, the income elasticity of demand is unity regardless of the value of the elasticity of substitution. (See equation (3).) Thus, notch subsidies are more attractive in the presence of low values of the elasticity of substitution, ceteris paribus.

II.7 Changing the Distribution of a

So far we have been assuming that the share parameter, a, is distributed uniformly over the interval (0,.1). We now consider some simple non-uniform linear distributions. Specifically, we continue to assume that there are a total of 499 people and that a runs between .0002 and .0998, but we make the density of a skewed. Figure III(a) shows the assumed distribution of a for a population with more F-lovers than F-haters; Figure III(b) shows the opposite case. Our analyses of non-uniform distributions assume Cobb-Douglas utility functions and these linear densities.

Results are reported in Table III. As before, for each configuration of utility function parameters, we present the equilibrium under the assumption of no subsidy, a linear subsidy of 20%, and the most efficient notch subsidy that induces the

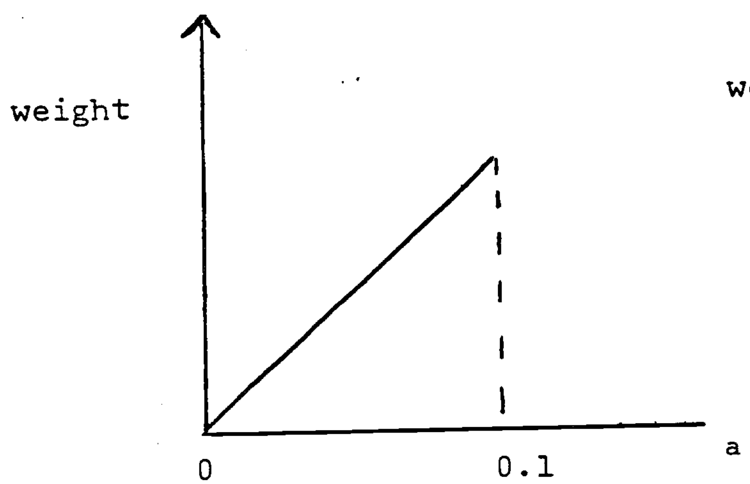

Figure IIIa

A Population with more F-Lovers

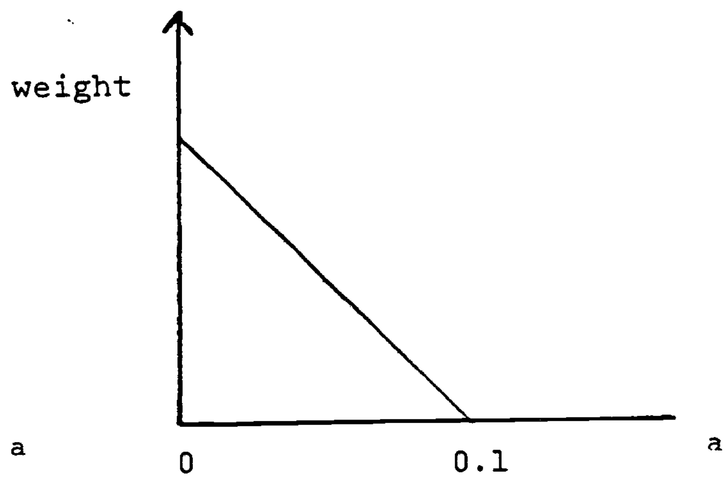

Figure IIIb

A Population with more F-Haters

Table III

Subsidy to Consumption of a Commodity
Cobb-Douglas Utility Functions
Linear Distribution of a

	More F-Haters			More F-Lovers		
	(1) Status Quo	(2) Linear Subsidy s=0.2	(3) Notch Subsidy F*=0.110 G=0.018	(4) Status Quo	(5) Linear Subsidy s=0.2	(6) Notch Subsidy F*=0.114 G=0.012
Total Demand for F	16.2	20.3	20.3	32.5	40.7	40.7
Total Revenue Loss	0	4.05	1.78	0	8.13	3.20
Total Excess Burden	0	0.42	0.97	0	0.82	1.38
TEC (m=0.2)	0	1.23	1.22	0	2.45	2.02
TEC (m=0.4)	0	2.04	1.69	0	4.07	2.66

same behavioral change as the linear subsidy.

Regardless of whether the population is comprised mostly of F-lovers or F-haters, the notch subsidy has much lower revenue costs, but much higher excess burdens than the linear subsidy. However, in all cases the notch subsidy is preferred on the basis of TEC -- albeit by a trivial margin in one case.

Note that on the basis of <u>relative</u> TEC, the notch subsidy is more preferred when the population is heavily weighted toward F-lovers. When m = 0.2 and the population has more F-haters, the TEC of the notch scheme is 98% of the linear subsidy's. But when the population has more F-lovers, the comparable figure is 82%.[12] Why? The fundamental advantage of a notch scheme is that it targets the subsidy to the "right" people. This advantage is worth most when many people have intense preferences for the commodity. With a lot of the population near the notch, few people have to be "dragged" very far in order to reach the notch, and therefore the excess burden per unit of induced consumption is relatively small.

II.8 Summary

We have compared notch and linear subsidies for stimulating consumption of a favored commodity, such as charitable giving. In every case we have examined, a notch subsidy can stimulate the same increase in consumption at a lower cost to the treasury. Hence, if revenue loss is the only criterion, the notch subsidy is clearly superior. However, if the increase in demand for the favored commodity induced by the subsidy is viewed as a distortion, then the associated excess burden must also be taken into account. Here, notch schemes seem to do systematically worse than linear subsidies. However, when the revenue costs and excess burdens are suitably aggregated to find a measure of total efficiency cost, the notch scheme often does better.[13]

In this context, it is important to remember that we did not set out to establish that notch schemes are generally, or even typically, superior to linear schemes. Our purpose was only to show that notch schemes might be superior under circumstances that are in no sense pathological. This seems to have been shown.

III. Some Practical Problems

Three major practical problems would arise in attempts to implement notch incentives:

1. Differences across income classes.

Our simulations examine populations with identical endowments. With a homothetic utility function, once a notch incentive that "works" for one income class is found, the same scheme can be scaled upward or downward and applied to every class. If people's utility functions are not homothetic, then the analysis must be done separately for each income group. Moreover, if policy makers wish to achieve certain distributional goals at the same time that behavior is being modified, then, as usual, efficiency criteria alone cannot be used to compare various plans. An explicit social welfare function with distributional weights must be introduced. Neither of these problems is "new" to the notch approach; they both arise in the linear case as well.

2. Bunching (Intertemporal Substitution)

Like all nonlinear tax and transfer plans, notch subsidies provide an incentive to bunch the subsidized activity into particular time periods. For example, if a $100 grant is given in any year in which charitable giving exceeds $1000, then individuals who would otherwise give $500 per year might instead give zero and $1000 in alternate years.

The seriousness of this problem depends on the context. In the case of charitable giving, it might be quite serious; bunching is therefore a formidable obstacle to the implementation of a notch subsidy. In other contexts, it might be less serious (see Section IV). Where intertemporal substitution is a severe problem, the remedy is obvious: lifetime averaging, which would make the lifetime, rather than the year, the relevant unit of time. In the case of charitable giving, averaging seems quite feasible. After all, the gift tax in the United States is now handled precisely in this way. In other applications, averaging may be more difficult administratively.

In any case, the principle is clear: notches will not look very attractive in applications where the elasticity of intertemporal substitution is high and/or where lifetime averaging is difficult.

3. Cheating (Interpersonal Substitution)

Taxpayers might collude in order to obtain notch subsidies or avoid notch taxes. If a grant of $100 is awarded to anyone who gives $1000 or more in a year, then two individuals who donate $500 each are ineligible. However, if one turns over his receipts to the other (or lets the other do his donating), the latter can claim the $100 subsidy, and then split it with his collaborator.

Is this likely to be a serious problem? It depends upon the transactions costs of such collaboration, and these will vary from case to case. In the case of transferring charitable contributions, these might be fairly low. (However, the answer depends in part on the importance that people attach to having <u>their</u> name associated with <u>their</u> contribution.) In contrast, cheating in other contexts seems less likely (see again Section IV).

IV. Conclusions

We have analyzed the consequences of notch incentives -- taxes and subsidies that create jumps in budget constraints -- as opposed to linear incentives, which simply change the slopes of budget constraints. Unlike linear incentives, notch schemes do not distort the behavior of every person. Rather, if properly designed, they induce individuals to self-select so that those who are most willing to change their behavior are the ones who receive the subsidy (or avoid the tax). In the cases we have examined, notch schemes do not uniformly dominate linear schemes. However, they come out on top often enough that they deserve serious consideration as policy options.

For purposes of exposition we have concentrated on the issue of charitable giving. However, a number of other possible applications exist:

a) Housing. Under current law, homeowners receive substantial tax benefits through the personal income tax. Ostensibly, the purpose of these provisions is to stimulate homeownership and they seem to have been effective in increasing the number of homeowners. But, at the same time, the subsidy increases the amount of housing purchased by homeowners (see Rosen (1979)). A notch scheme targetted just at homeownership -- a lump sum reduction of tax liability for those who own homes -- could be designed to have the same effect on the homeownership rate, with less severe revenue and efficiency consequences. Since the subsidy for homeownership would presumably apply only to one house per family, neither intertemporal nor interpersonal substitution should create problems.[14,15]

b) Education. Currently, tuition tax credits are being considered as a way to promote higher education. A notch version of this scheme could give a family a lump sum payment only after (say) a certain number of years of college education had been bought. Since each child in the household could receive the subsidy only once, the bunching issue would not arise. And cheating would require falsification of college records. Hence neither problem seems important in this context.

c) Saving. There are several provisions in the tax code designed to encourage saving, and others have been proposed. Generally, these are linear subsidies that raise the return to saving, perhaps up to some maximum amount.[16] Consider as an alternative a notch subsidy that offers a lump sum grant to those who save more than a certain amount. (The threshhold amount would obviously be keyed to income.) We have done some extensive simulations with such plans, and found that they often (but not always) are a better way to stimulate saving than replacing the income tax by a consumption tax.

The drawback is a practical one: intertemporal substitution is a potentially devastating problem in this case. Individuals can easily bunch their saving into particular years so as to avail themselves of the notch subsidy without really saving more in the long run. Indeed, the problem is worse than that because savings eligible for the subsidy would presumably have to be deposited into particular accounts (analogous to IRAs). Individuals could easily transfer funds into and out of these accounts in order to give the appearance of bunching their saving even though, in fact, they were saving at a smooth rate. In brief, the problem of intertemporal substitution may preclude the use of notch subsidies to encourage saving.

d) Welfare Reform. As mentioned in the introduction, our current welfare system is characterized by notches that provide strong disincentives to work. In particular, poor families lose substantial benefits such as Medicaid and public housing when their earnings cross certain threshholds. Economists have strongly condemned the current system for its adverse incentives. Many have advocated replacing it by a negative income tax (NIT) which would, in essence, get rid of the notches. Both *a priori* reasoning and empirical evidence support the idea that an NIT is a better way to redistribute income than our current welfare system.

We, naturally, join the condemnation of the present system and agree that an NIT would be better. But we believe that the problem with the current system is not so much that it employs a notch as that it employs a *perverse* notch. It is possible that a notch welfare system would provide positive work incentives for the working poor.

Specifically, consider the following sort of welfare plan. Individuals are offered a lump sum grant, G, on the condition that they work at least a certain number of hours, H*, per year. If they work less than H* hours, they receive nothing.[17] In a set of simulations not reported here, we compared the current welfare system, an NIT, and a notch scheme. The notch scheme not only dominated the *status quo*, but for certain configurations of the parameters, it stimulated more labor supply with less excess burden than the NIT.

Interestingly, neither intertemporal nor interpersonal substitution would likely be a problem for a notch welfare scheme of the sort we propose. Low-wage people have limited opportunities to vary their hours of work, and a year is already a long time period as such decisions go. Similarly, the costs of cheating are probably very substantial in the welfare case. Presumably, worker A would have to get his employer to report some of his earnings as if they had been earned by worker B; this requires the complicity of the employer. Then worker B would have to be trusted to share the subsidy check that he receives from the government. The whole thing sounds quite cumbersome. These and other considerations lead us to suspect that cheating might not be a major problem for a welfare system that featured a notch incentive to work.

We have emphasized throughout that the results depend on the distribution of individual tastes and endowments. If the ideas advanced here are deemed to be fruitful, the natural next step would be to simulate the effect of notch subsidies for realistic programs using estimated utility function parameters for a sample of actual consumers. Such a study would provide a more definitive basis for evaluating the efficacy of notch incentives. All we have done here is to drop a few, hopefully provocative, hints.

FOOTNOTES

1. The optimal tax literature has discussed general conditions under which nonlinear taxation is more efficient than linear taxation. See Seade [1977]. A notch incentive can be viewed as a special case of a nonlinear tax which is sufficiently simple that it is a viable policy option. The two-part tariff is another well-known example of how departures from linear pricing can enhance welfare.

2. There are a number of other ways to define excess burden, but for our purposes the differences are inconsequential. See Auerbach and Rosen [1980].

3. The indirect utility function (5) cannot be used because of the discontinuity in the slope of the budget constraint at F^*.

4. That there are 499 individuals rather than 500 is a quirk of the simulation. Originally, we had let the parameter a run between .002 and .998, and were forced to omit both endpoints in order to get an interior solution. When we moved the decimal point on a we neglected to include $a=.10$.

5. Actually, for computational reasons, our "Cobb-Douglas" case is $\sigma = 1.01$.

6. Note that the product of price times quantity is approximately unchanged (that is, 30.5 x 0.8 = 24.3) because of

the Cobb-Douglas utility function.

7. To cite just one comparison, Weicher (1979) presents estimates that each $1 spent on public housing yields about 85 cents worth of benefits to recipients.

8. Since our tax changes are not infinitesimal, we should really use the average marginal rate over the relevant range, which would presumably exceed m.

9. It is far from obvious that this is the rationale for government subsidization of charitable giving.

10. This discussion assumes that only the aggregate quantity of the externality-producing commodity matters. In the case of classical externalities, efficiency requires that <u>each person's</u> consumption of F be such that the social marginal benefit equals the marginal cost. Just like standard Pigouvian subsidies, our scheme ignores the fact that the optimum corrective subsidy or tax generally differs across individuals.

11. We also report results for m=0.4. The characteristics of the notch schemes that minimize TEC for m=0.4 are not very different from those that minimize it for m=0.2. The minimum was found by using a simple grid search.

12. Observe from Table I that the comparable figure for a uniform distribution lies between these two.

13. Presumably, a two-parameter subsidy scheme that combines a notch with a conventional linear subsidy would be superior to either pure system. Indeed, this is the case. But

when we experimented with such a mixed system, we found that the optimal two-parameter scheme combined a very large notch with a linear tax.

14. Australia currently awards a lump sum subsidy to first-time purchasers of houses. We thank Brian Wright for informing us of this.

15. Interestingly, a federally sponsored social experiment conducted several years ago investigated a notch subsidy to stimulate the consumption of rental housing by the poor. Each family in the experiment received a lump sum grant if its monthly housing expenditure exceeded some critical amount. See Venti and Wise (1984) for details.

16. Bradford (1980) provides a survey of these items.

17. The system we outline provides nothing for households unable to work. Thus it must be viewed as one component of a categorical system that also includes an outright dole for those judged unable to work. Of course, the administrative difficulties posed by categorical systems is one reason why many reformers favor the NIT. It is far from clear, however, that any real world welfare system can be entirely non-categorical. It is hard to imagine the political process allowing a healthy full-time college student to receive NIT payments, for example.

REFERENCES

Auerbach, Alan J. and Harvey S. Rosen, "Will the Real Excess Burden Please Stand Up? (Or, Seven Measures in Search of a Concept)," National Bureau of Economic Research, Working Paper No. 495, June 1980.

Ballard, Charles L., John B. Shoven, and John Whalley, "The Welfare Costs of Distortions in the United States Tax System: A General Equilibrium Approach," National Bureau of Economic Research, Working Paper No. 1043, December 1982.

Bradford, David, "The Economics of Tax Policy Towards Savings," in George M. von Furstenberg (ed.), The Government and Capital Formation, Ballinger, 1980.

Hausman, Jerry A., "Income and Payroll Tax Policy and Labor Supply," in Laurence Meyer (ed.), The Supply Side-Effects of Economic Policy, St. Louis Federal Reserve Bank, 1981.

Rosen, Harvey S., "Housing Decisions and the U.S. Income Tax: An Econometric Analysis," Journal of Public Economics, 11, February 1979, 1-23.

Seade, Jesus, "On the Shape of Optimal Tax Schedules," Journal of Public Economics, 7, April 1977, 203-235.

Stuart, Charles E., "Welfare Costs Per Dollar of Additional Tax Revenue in the U.S.," American Economic Review, 74, June 1984, 352-362.

Venti, Steven F. and David A. Wise, "Moving and Housing Expenditure: Transactions Cost and Disequilibrium," Journal of Public Economics, 23, February/March 1984, 207-243.

Weicher, John C., "Urban Housing Policy," in P. Mieszkowski and M. Straszheim (eds.), Current Issues in Urban Economics, The Johns Hopkins Press, 1979.