A GENERAL EQUILIBRIUM ANALYSIS OF EXCISE TAXES

By PAUL WELLS*

This paper will present a theory of the incidence of both the burdens and benefits an excise tax exerts in a two-person, two-factor, two-commodity, perfectly competitive world.[1] Although this attempt may appear to be unnecessarily modest, excise tax theory should be clear on this first step before additional complicating considerations are introduced to make the analysis more realistic. The main conclusions of this paper are: (a) that an excise tax exerts both a burden—an aspect of excise taxes long recognized and much discussed in the literature[2]—and a benefit, an aspect of excise taxes that has been little discussed in the literature; and (b) that these burdens and benefits fall on individuals as buyers and sellers of goods and services, and that the degree to which the burdens and benefits of an excise tax spread out from one individual or group of individuals to another individual or group of individuals will depend upon the preference functions of all individuals, the asset structure of all individuals, the tax and expenditure policy of the taxing agency, and the nature of the transformation functions of the commodities produced. We shall demonstrate these conclusions for our two-dimensional world, and then consider how far it is possible to go in generalizing from it.

* The author is a graduate student in economics at Stanford University. He is indebted to Dr. John Fei, Massachusetts Institute of Technology, and to Professor Elmer D. Fagan, Stanford University, for helpful suggestions concerning the analysis contained in this paper.

[1] Recent attempts, along much different lines from the one to be followed in this paper, to subject incidence theory to a general equilibrium analysis have been made by E. R. Rolph, "A Proposed Revision of Excise-tax Theory," *Jour. Pol. Econ.*, Apr. 1952, LX, 102-17, and "A Theory of Excise Subsidies," *Am. Econ. Rev.*, Sept. 1952, XLII, 515-27; R. A. Musgrave, "On Incidence," *Jour. Pol. Econ.*, Aug. 1953, LXI, 306-23, and "General Equilibrium Aspects of Incidence Theory," *Am. Econ. Rev.*, Proceedings, May 1953, XLIII, 504-17; J. A. Stockfisch, "Excise Taxes: Capitalization-Investment Aspects," *Am. Econ. Rev.*, June 1954, XLIV, 287-300. See also J. F. Due, "Toward a General Theory of Sales Tax Incidence," *Quart. Jour. Econ.*, May 1953, LXVII, 253-66.

[2] *Cf.* F. Y. Edgeworth, "The Pure Theory of Taxation," *Econ. Jour.*, Mar. 1897, VII, 46-70; A. Marshall, *Principles of Economics*, 8th ed. (New York, 1949), pp. 413-15; E. D. Fagan, "Tax Shifting and the Laws of Cost," *Quart. Jour. Econ.*, Aug. 1933, XLVII, 680-710, and the literature there cited.

I. *The General Equilibrium Model*

In formulating the General equilibrium model to be used,[3] we need, in addition to the assumptions usually required by perfect competition, the following assumptions: (a) Two people, a farmer called A and and a worker, B; (b) Two factors of production: land and labor, fixed in supply and completely owned by A and B; (c) The ratio of land to labor owned by A exceeds the land-labor ratio of the economy;[4] (d) Two products: food and clothing, each of which requires the use of both land and labor for its production; (e) The production functions for food and clothing are homogeneous and of the first degree; (f) The production of food is a relatively land-intensive industry and the production of clothing a relatively labor-intensive industry.

With these assumptions, we can develop the following functions:

1. A production-possibility function between food and clothing (PP' in Figure 1).

2. A division-of-output function (KL). This function states the ratio in which output is divided between A and B for all possible output combinations to be found in PP', and can be used to show the degree to which the division of output between A and B changes as a consequence of, say, the levying of an excise tax on one of the two commodities. If we let the radial line OJ_1 be an index of output J_1, then the intersection of the KL function with this index states the ratio OD_1/D_1J_1 in which output J_1 will be divided between A and B in payment for the services of land and labor given up to the productive sector by A and B, with OD_1 of OJ_1 output going to A and the remainder, D_1J_1, going to B. From the shape of the KL function we notice that A's share of output increases, and B's decreases, as more food and less clothing are produced. This follows from assumptions (c) and (f). Assumption (f) requires the price of land to rise relative to the price of labor as more food and less clothing are produced; and, as a consequence of assumption (c), A's share of output will increase and B's decrease. The curvature of KL at, for example, any point D_1—that is, the degree to which the division of output would change as a consequence of a small change in the pattern of output from that shown by J_1—depends upon: (a) the absolute difference in the proportions in which the two factors are combined, respectively, in the two industries when the output is J_1. The greater this difference is, the greater must be the change in relative factor prices to effect a given change in output, and hence, the greater will be the change in the division of output between A, the owner mainly of land, and B, the owner mainly of labor.

[3] The model used was originally conceived of by J. Fei, and jointly developed by Fei and the author.

[4] The ratio of land to labor owned by B will necessarily fall short of the land-labor ratio of the economy.

(b) The difference in the ratio of land to labor owned by A and B. The greater is this difference, the greater will be the change in the division of output between A and B that will result from a small change in the pattern of output from J_1. The position of KL with respect to the origin depends upon the absolute amounts of land and labor owned, respectively, by A and by B. The more of both factors A owns, the farther out from O will KL be. Rather than develop the KL function rigorously—which is, at best, a tedious operation—we shall let this intuitive argument suffice.[5]

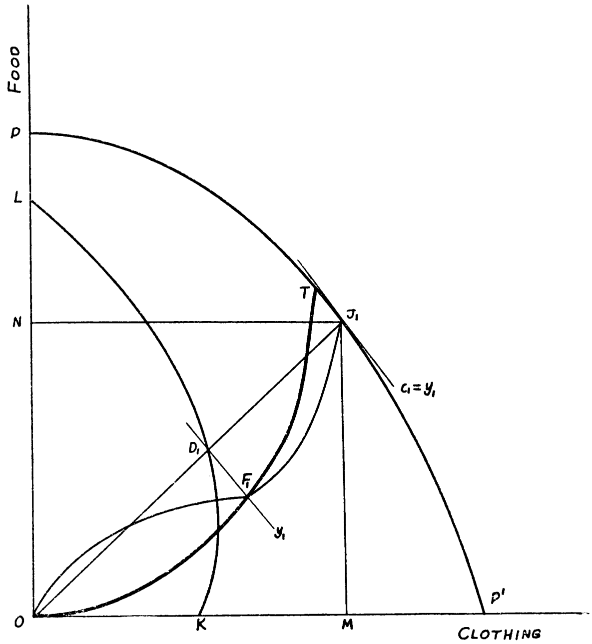

FIGURE 1

3. A specific contract curve (OF_1J_1 in Figure 1). This function is the locus of points for a particular output which satisfy the Paretian general optimum of exchange. For any possible output combination such as J_1 there is a box ONJ_1M "belonging" to that output. The dimensions of the box give the total amounts of food and clothing available for consumption by both A and B. If we place the origin of A's indifference map at O and the origin of B's map at J_1, then it is possible to define the locus of point such that it is not possible to increase the welfare of either A or B without reducing the welfare of either one or the other by a redistribution of the given output between the two. The

[5] For a somewhat different discussion of this relation, *cf.* W. F. Stolper and P. A. Samuelson, "Protection and Real Wages," *Rev. Econ. Stud.*, Nov. 1941, IX, 62-69 (also reprinted as Chapter 15 in *Readings in the Theory of International Trade*, ed. by H. S. Ellis and L. A. Metzler [Philadelphia, 1949], ff. 335-57).

locus is the Edgeworth contract curve. Since each point on PP' defines a consumption box and a specific contract curve there exists a family of specific contract curves, one for each possible output combination. An important characteristic of specific contract curves is that the slopes (marginal rates of substitution) at which the indifference curves of A's system are tangent to those of B's system are free to vary throughout the length of the specific contract curve.

4. A generalized contract curve (OF_1T). This function is the locus of points which satisfy the Paretian general optimum of both production and exchange for our model. We saw previously that for any specific output on PP' there is a locus of points associated with that output such that the marginal rate of substitution of A in consumption is equal to that of B. We shall see now that it is possible to define, for any specific output on PP', a single point on its specific contract curve such that the common marginal rate of substitution of A and B is equal to the marginal rate of transformation of that output to which the specific contract curve belongs. By finding one such point for each of a large number of specific outputs we shall have a large number of points for each of which the common marginal rate of substitution equals the marginal rate of transformation; the line traced out by these points we shall call the generalized contract curve.

To locate points on the generalized contract curve, select an output J_1 (Figure 2), and draw the box ONJ_1M belonging to that output. As before, place the origin of A's indifference map at O and let it range to the northeast. Place the origin of B's map at J_1 and let it range to the southwest. Instead of drawing in the contract curve specific to output J_1, draw in the income-consumption curve of A (OF_1GJ_1 in Figure 2) and the income-consumption curve of B (J_1F_1HO), both with reference to the price y_1. Since y_1, the relative price we take to be constant for the purpose of deriving the income-consumption curve for A and for B, is equal to the marginal rate of transformation at J_1, the income-consumption curve of A is the locus of points for which the marginal rate of substitution of A in consumption is equal to the marginal rate of transformation at J_1. The same is true for the income-consumption curve of B. At the point of intersection of these two curves (F_1 in Figure 2), the common marginal rate of substitution of A and B will be equal to the marginal rate of transformation for output J_1. Hence, F_1 is a point on the generalized contract curve, and we may say that point J_1 on the production-possibility function "contributes" point F_1 to the generalized contract curve. It may be noted that the contract curve specific to output J_1 (not shown in Figure 2) also necessarily passes through F_1.

By selecting various other points on PP' different income-consump-

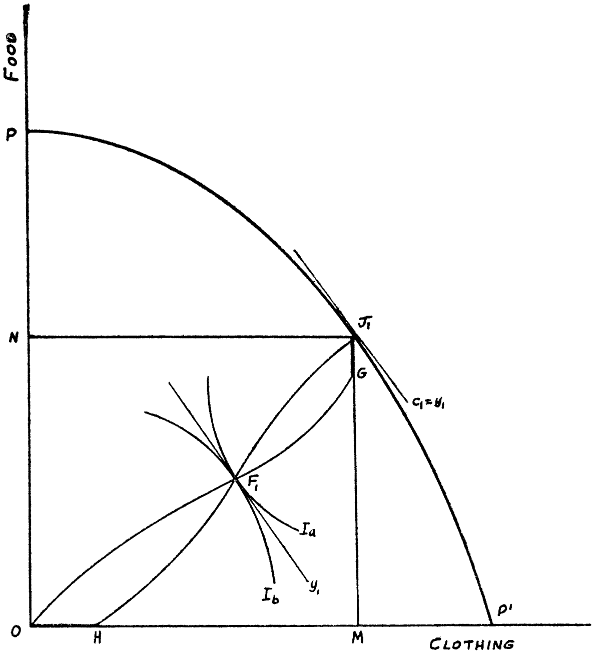

FIGURE 2

tion curves for A and for B can be constructed; and their intersections will give additional points on the generalized contract curve.[6] By connecting these points we draw in OF_1T (Figure 1).

The economic significance of the generalized contract curve in conjunction with the production-possibility curve is that if competition does exist, then the general equilibrium established will yield a pair of points, one on the production-possibility curve and the other on the generalized contract curve, such that the marginal rate of transformation (opportunity costs) between food and clothing in the productive sector will be equal to the marginal rate of substitution between food and clothing for both A and B in the exchange market. This condition is represented in Figure 1 by all possible pairs of points J and F; that is, a point on the production-possibility curve and the point contributed to the generalized contract curve by this point on the production-pos-

[6] It is possible to select points on the production possibility function which "have" noninteresecting income-consumption curves. Since the forces of competition would never lead the economy to such a point on PP' we can disregard these points.

On the other hand, it is entirely possible that a pair of income-consumption curves could intersect more than once. Such an *embarras de richesse* would make it very difficult actually to draw in the generalized contract curve, as has been done in Figure 1, but would in no way alter, or detract from the meaning or significance of the generalized contract curve.

sibility curve. Thus any pair of points J and F fulfills the conditions of the Paretian general optimum of production and exchange for our model.

To summarize, our model of general equilibrium contains the following elements: a production-possibility function (PP' in Figure 1); a generalized contract curve OF_1T; a family of specific contract curves of which OF_1J_1 is the contract curve specific to output J_1; a division-of-output function KL; and an index of output OJ_1. Full equilibrium in a competitive model will establish a pair of points such as J_1 and F_1. If an output J_1 is established, then opportunity cost will be c_1, with OD_1 of OJ_1 output going to A and the remainder D_1J_1 going to B in payment for the services of land and labor given up to the productive sector by A and B (Figure 1). Given their initial holdings of food and clothing, A and B will engage in trade at some price which will carry them onto the specific contract curve of output J_1. If we have, by luck, chosen the general equilibrium output, then the price established in the exchange market, y_1, will be equal to c_1, and the exchange that A and B engage in will carry them not only onto the specific contract curve at F_1, but also onto the generalized contract curve, since F_1 is the point contributed to the generalized contract curve by J_1. Full equilibrium will be established with the marginal rate of transformation (c_1) equal to the marginal rate of substitution for both A and B (y_1).

To facilitate the analysis of excise taxes, we shall make one more assumption with respect to the organization of the economy: The productive sector is assumed to be entirely separate from the exchange market and the only information the productive sector has on which to act, aside from a knowledge of production functions, is the relative prices of goods and services; that is, A and B, as exchangers, are assumed not to communicate directly with the productive sector.

II. *Price, Output, and Income Effects*

We turn now to the analysis of the effects that an excise tax on one of the two commodities will have on commodity and factor prices, the composition of output, the division of output between A and B, and the welfare of A and B. The pair of points J_1 and F_1 in Figure 3 characterize a possible competitive equilibrium position of our system in the absence of any excise taxes. Now let an excise tax of x per cent be applied to the sale of clothing. This means that the purchasers of clothing will be required to pay for it a price of $(y_1 + t_1)$, where t_1 is x per cent of y_1 while the purchasers of food will be able to exchange clothing for food at the old price of y_1 as long as output J_1 persists. The first and lasting effect of this tax is to destroy the efficiency with which output J_1 is

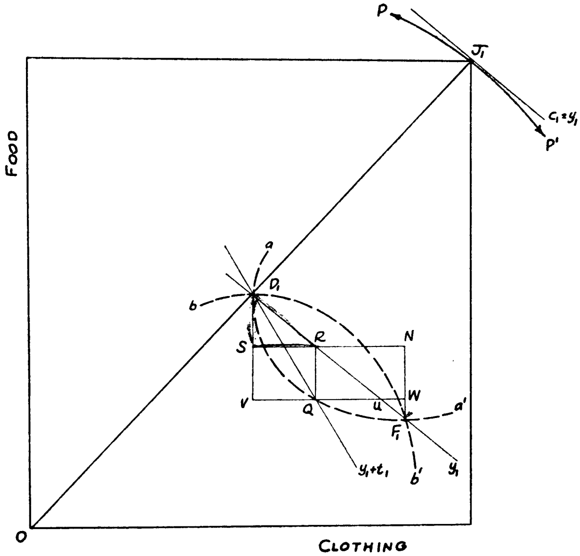

FIGURE 3

distributed by requiring A to pay a different price for clothing $(y_1 + t_1)$ than B receives (y_1) for selling clothing to A.[7] With different prices facing our two exchangers, it is no longer possible for both A and B to equate their marginal rates of substitution between food and clothing to a single price, and hence the marginal rate of substitution between food and clothing will no longer be the same for A and for B. A second effect of the tax is to destroy the equilibrium of the system and to require a new general equilibrium to be found which is consistent with the tax on clothing.

At the new price $(y_1 + t_1)$ confronting him, A would want to exchange food for clothing until he again equated his marginal rate of substitution to price. This would occur at point Q, the intersection of $(y_1 + t_1)$ with A's offer curve aa', which would require A to exchange D_1V food for VQ clothing. On the other hand, since B is a seller of clothing and a buyer of untaxed food, his plans would not be affected by the tax on clothing. Price y_1 would remain the price at which he could exchange clothing for food, and point F_1 would continue to be the optimal position in consumption for B. However, since B can sell

[7] "An excise tax interferes with allocating efficiency, because it makes the relative price of the taxed commodity different for different members of the community—producers being interested in the price net of tax, and consumers in the price including tax." T. Scitovsky, "A Reconsideration of the Theory of Tariffs," *Rev. Econ. Stud.*, Summer 1942, IX, 94 (also reprinted as Chapter 16 in *Readings in the Theory of International Trade*, ed. by H. S. Ellis and L. A. Metzler [Philadelphia, 1949]).

to A only as much clothing as A is willing to purchase, B's sales of clothing would, as Figure 3 indicates, fall short of that amount necessary to allow him to reach point F_1. At the existing pair of prices, A would purchase VQ (equal to SR) clothing from B with D_1V food, D_1S of which would go to B in payment for SR clothing, with the balance SV taken by the taxing agency. Exchange between A and B to this extent only, while allowing A to locate at his optimal position in consumption, Q, would leave B located at point R, a suboptimal position with respect to price y_1, unable to engage in the further exchange which would be necessary to carry him to F_1 for want of a buyer of clothing. If, then, trade is carried on until the pair of points Q and R are reached in consumption by A and B, the existing pair of prices y_1 and $(y_1 + t_1)$ would have failed to clear the market, for B would be left with an excess supply of clothing equal to RN and an excess demand for food equal to NF_1. Since the productive sector responds to, and only to the signals of excess supply and demand, more food and less clothing will be produced, and the original pair of prices and output will not persist.

Adjustments in output will be carried out in the productive sector, which will in turn require changes in relative factor prices, until an output is arrived at in the productive sector and a pair of prices is found in the exchange market which clears the market; that is, a pair of prices which makes it possible for A to equate his marginal rate of substitution between food and clothing to the price-plus-tax, and B to equate his marginal rate of substitution to the price established, with excess supply and demand of either commodity equal to zero.[8] In Figure 4, let this pair of equilibrium prices be y_2 and $(y_2 + t_2)$, and let the output be J_2. The price of food would be higher than that shown by y_1 in Figure 3, and the price of clothing including tax would be lower than that shown by $(y_1 + t_1)$. The new output, J_2, would be made up of a higher proportion of food than in the case of J_1. The division-of-output function would tell us, if it were drawn in, that OD_2 of food and clothing would go to A and the remainder to B. A will exchange D_2V food for VQ clothing and locate at point Q in consumption. B will exchange VQ clothing for D_2S food and locate at point N in consumption. The remainder of the food, SV, will go to the taxing agency, and for the present we ignore the possible effects of the spending policy of this agency. Both A and B achieve their optimal positions in consumption,

[8] It is not within the scope of this paper to discuss the stability conditions of the model. We shall assume that positions of stable equilibrium do exist. It can be shown that stability depends on the preference functions of all individuals, the asset structure of all individuals (by this we mean the ratio in which individuals hold land and labor and not the absolute amounts held), and the production functions of all commodities. The more similar are the first two among individuals and the last among commodities, the more stable will the system likely be. It appears that similarity breeds stability.

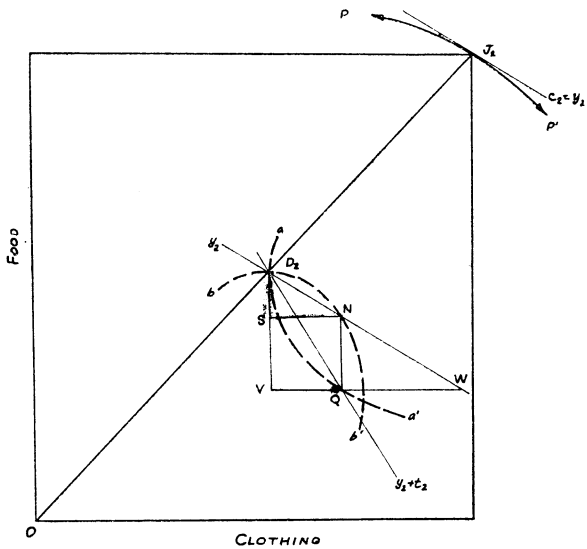

FIGURE 4

given their "incomes" and the prices that confront them. There exists no excess supply or demand of either commodity. Hence, the triplet of points J_2, N, Q characterizes a full general equilibrium position of the model given an excise tax of x per cent on clothing.

Since the points N and Q are not on the specific contract curve of output J_2, they can hardly be on the generalized contract curve. The economic significance of this is that not only has the distributive efficiency of the system been impaired (by the dual prices), but so has the productive efficiency of the system been impaired. This is true because for at least one individual (in this case A), the marginal rate of transformation of food into clothing does not equal the marginal rate of substitution between food and clothing. The taxing agency has reduced the welfare of the community A-B in two distinct ways:[9] first, by withdrawing SV amount of food from the market; and second, by establishing a tax structure such that it is not possible to satisfy the conditions of the Paretian general optimum of production and exchange.[10]

[9] At this point we cannot say that the taxing agency has reduced the welfare of A and/or B for as yet we do not know if either A or B is worse or better off. We know that either A or B must be worse off and that perhaps they are both worse off. We shall further explore this matter shortly.

[10] The same tax SV could be collected in another way so as not to impair the productive or distributive efficiency of the system (*cf.* R. K. Davidson, "The Alleged Excess Burden of an Excise Tax in the Case of an Indiviudal Consumer," *Rev. Econ. Stud.*, 1953, XX, 209-15). We might ask at this point, why does not A escape the burden of paying an excise tax on clothing by taking his D_2V food, not to the exchange market for VQ

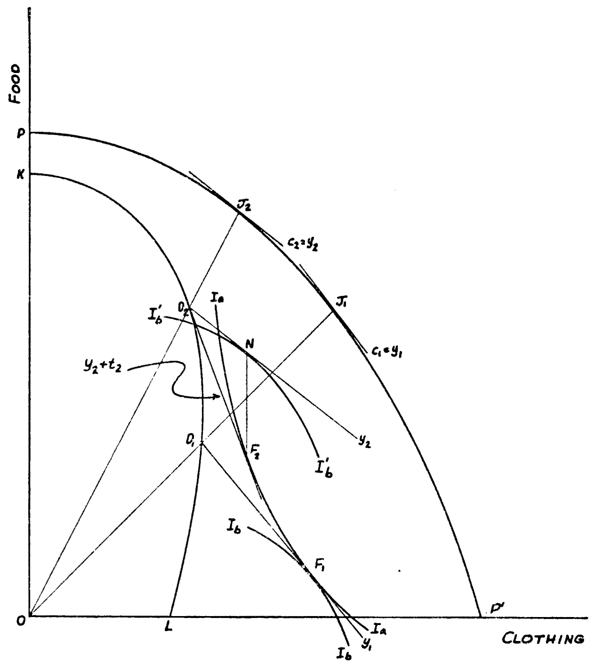

FIGURE 5

At first glance it looks as if the burden of the excise tax falls directly and entirely on *A*, the purchaser of clothing, and not at all on *B*, the purchaser of food. But because *A* "pays the tax" in the crude sense of handing over a certain amount of food to the taxing agency, this does not mean that the entire burden of the tax does fall on *A*, in the sense that *A* becomes worse off after the tax is levied, and that *B's* welfare is unaffected by the tax on clothing. In fact, it is possible to define situations in which *A* is better off as a result of the tax, and situations in which his welfare is unaffected by the tax, as well as situations in which he is made worse off by the tax.

From the shape of the *KL* function in Figure 5 we see that when clothing is taxed and, as a result, the output of food increases, *A*'s share of output increases. This is because *A* owns a more than proportionate

clothing, but to the productive sector and transform it into *VW* clothing? The answer is that we assume that the productive sector responds to the signals of excess supply and demand only and not to the implorings of individuals. In the economy of the United States it is not possible for individuals to go to Durham, say, and directly transform their labor power into cigarettes to avoid paying federal, state, and local taxes. An excise tax on clothing can be collected only if clothing is purchased in the exchange market, and although *A* may refrain from buying clothing, he is forbidden to transform his excess supply of food into clothing in the productive sector.

share of land, the factor whose relative price increases as the output of food increases. The question now is whether A will be better or worse off after paying taxes on the clothing he purchases. It is possible to conceive of an after-tax equilibrium such that we would have an output combination J_2 (Figure 5), a pair of prices y_2 and $(y_2 + t_2)$, and a division of output D_2 which together would result in A being just as well off after the tax as before the tax, leaving the full burden of the tax to be borne by B. In this special case the benefit of an increased price for labor accruing to A would be just offset by the burden of an increased price for clothing on A. With output J_2 divided at D_2 and with a price for clothing of $(y_2 + t_2)$, where y_2 is less than y_1, but $(y_2 + t_2)$ is greater than y_1, A would exchange food for clothing up to F_2, on indifference curve I_a, the curve he was originally on at point F_1. B would exchange clothing for food at a price y_2 up to point N on indifference curve I'_b, which is lower in his preference system than is curve I_b, the curve he was originally on at point F_1. Hence, even though A pays the tax by handing over to the taxing agency F_2N food as he purchases clothing, the entire burden of the excise tax would be shifted to B if output were to change in response to the excise tax from J_1 to J_2.

For shifts of output into food greater than the shift from J_1 to J_2, A's post-tax position will actually be superior to his pretax position, and B would suffer not only the entire tax burden, but also the burden of A's enhanced income position. For shifts of less than J_2, the burden of the tax will be divided between A and B, with A bearing the entire burden in the unlikely event that there is no output shift into food. In the even more unlikely case of clothing being an inferior good to A, a tax on clothing would give rise to a greater output of clothing, and A would then bear the entire burden of the tax plus the burden of B's superior income position.

The magnitude of the output shift into food required to place the entire burden of the tax on B depends upon the rate at which A's share of output increases as more food is produced. This rate, shown by the curvature of KL, as we have seen[11] depends mainly on the following two factors: (a) The ratio in which A (and hence B) own land and labor. The greater the ratio of land to labor owned by A the greater will be A's increase in the share of output as more food is produced. (b) The difference in factor utilization between the labor-intensive clothing industry and the land-intensive food industry. When factor intensities are different a change in the composition of output will require, assuming full employment, factor-price changes in favor of the factor intensively used by the expanding industry, which in this case, is land. The

[11] *Supra,* p. 346.

greater is this difference in factor intensities, the more the price of land must rise and the price of labor fall, and the more will A benefit by a given change in the composition of output in favor of food.

The actual change in the composition of output in favor of food that does take place in any given case depends upon the following four factors:

1. The excise tax levied on clothing. The greater is the excise tax levied on clothing, the greater will be the shift into food.

2. The marginal rate of substitution for A and for B between food and clothing. The closer substitutes food and clothing are for A, the greater will be A's shift into food when clothing is taxed. For B, as more food is produced, its price in terms of clothing will increase, and the less close substitutes these two commodities are, the less rapidly will B decrease his consumption of food as its price increases.

3. The tax-expenditure policy of the taxing agency. The greater is the proportion of tax receipts "spent" on food, the greater will be the output shift into food. In the above analysis we have implicitly assumed that the taxing agency purchased no clothing from B and did purchase, in effect, only food with its tax receipts. Alternatively, the taxing agency could spend its entire tax receipts SV (Figure 3) on QU clothing by engaging in exchange with B at the untaxed price of y_1. As a result of this additional exchange B would find it possible to locate at point U in consumption and consequently his excess supply of clothing would be reduced from RN to UW and his excess demand for food reduced from NF_1 to WF_1. The increase in the output of food and the decrease in the output of clothing necessary to wipe out the existing excess supply and demand for clothing and food, to bring the system into general equilibrium, would then be smaller than before. If point U were located on top of point F_1, then the equilibrium of the system would not be disturbed by the tax, for both excess supply and demand would remain equal to zero. There would then be no change in the composition of output in response to the tax on clothing and the entire burden of the tax would fall on A, the purchaser of taxed clothing. For a more complete analysis of the equilibrium position of the system after an excise tax is applied, knowledge of a "government preference function" or a set of expenditure plans stating the proportions of food to clothing on which the taxing agency would spend its tax receipts at various levels of prices and receipts would be required.

4. The difference in the land-to-labor ratio used in the labor-intensive clothing industry and the land-intensive food industry at given factor prices. The smaller is this difference, then the closer substitutes food and clothing are for each other in production. The closer the two commodities are substitutes for each other in production, the greater will be the

output response of food to a given increase in the price of food. In geometric terms, the closer food and clothing are substitutes for each other in production, the flatter will be the curvature of PP', the production possibility curve, in the neighborhood of point J_1 (Figure 3). The more closely PP' parallels y_1 in the neighborhood of J_1, then the greater will be the increase in the output of food in response to a given increase in the price of food.

Hence, the manner in which the incidence of the burdens and benefits of an excise tax rests upon A and B depends upon the production functions of both commodities, the structure of asset holdings and the preference functions of both individuals, and the government tax and expenditure policy. This is, of course, not a surprising result, and many economists might have long suspected that a careful application of general equilibrium analysis would yield these conclusions as a matter of course.

III. *Conclusions*

It has not been possible for the author to construct an analogous model for an n-dimensional economy. However, on the basis of the preceding analysis, it does appear possible to draw a few rather weak conclusions regarding the burdens and benefits an excise tax will bring about in a more complicated economy.

In the usual case where elasticities of demand are greater than unity, total spending on the output of any given industry will decrease as that industry is taxed. The output of the taxed commodity will decrease and its price will increase. Demand for the complements of the taxed commodity will decrease and both the price and output of these commodities will fall. Resources will be released by the taxed industry and industries producing commodities complementary to the taxed commodity. Increased spending will be directed toward the output of industries producing substitutes for the taxed commodity and to the industries producing commodities complementary to the substitute commodities of the taxed commodity. Additional resources will be demanded by these expanding industries. If the economy is to respond to the change in spending with a change in the composition of output, it will be necessary for relative factor prices to change if it is the case—as a priori appears likely—that the contracting industries employ factors, and hence release them, in different proportions from those characteristic of the potentially expanding industries.[12] The relative prices of certain factors will fall, irrespective of whether they are employed by

[12] On this point, see J. Robinson, "Rising Supply Price," *Economica*, N. S., Feb. 1941, VIII, 1-8; reprinted in *Readings in Price Theory*, ed. by G. J. Stigler and K. E. Boulding (Chicago, 1952), pp. 233-41.

the contracting industries or all other industries,[13] and the owners of these factors will be, *ceteris paribus,* worse off because of the tax. The relative prices of certain other factors will rise, no matter where they are employed, and the owners of these factors will be, *ceteris paribus,* benefited because of the tax. In order to know just which factors will be made worse off and which better off, it would be necessary to know: (a) the industries away from which consumers direct their spending, and the industries toward which they direct their spending, as the output of one industry is taxed; (b) the direction of spending of the additional tax receipts by the taxing agency; and (c) the proportions in which the expanding industries and the contracting industries employ the various factors of production. The excise tax will also exert a burden on the consumers of the taxed commodity, the substitutes of the taxed commodity, and the complements of these substitutes; and the burden will be heaviest for those consumers for whom there exist few, or no close substitutes for the taxed commodity. The excise tax will benefit not only those owners of factors of which the prices have increased, but also the consumers of the complements of the taxed commodity.

Again, if we knew the preference functions and asset holdings of all individuals, the production functions of all commodities, and the tax and expenditure policy of the taxing agency, we could arrange all individuals on a "benefit-burden" scale according to how their welfare is affected by an excise tax on a particular commodity or group of commodities. The burden limit of this scale would be occupied by those individuals whose welfare would be reduced the most by the effects of the tax: those individuals who are heavy consumers of the taxed commodity, its substitutes, and the complements of its substitutes—that is, consumers who happen to have strong preferences for those commodities whose prices increase because of the tax—and who are also owners of factors which are intensively used by the contracting industries and which suffer a relative price decrease. The benefit limit of the benefit-burden scale would be occupied by those individuals whose welfare would be increased the most by the effects of the excise tax: those individuals who have strong preferences for the complements of the taxed commodity and for whom there exist many close substitutes for the taxed commodity, and who are also owners of factors intensively used by the expanding industries. The remaining individuals fall somewhere between these limits, depending on how strongly the benefit-burden forces of increased—or decreased—commodity and factor prices operate on each individual as a consumer and as a factor-owner.

Unfortunately, it appears that for the n-dimensional case, just as for

[13] Since factors of production are assumed to be mobile.

the two-dimensional case, more knowledge is necessary than is available to place individuals on such a benefit-burden scale. Even worse, one crude inference which it was possible to make in the two-dimensional case cannot be made for the n-dimensional case. We know that with only a labor-intensive clothing industry and a land-intensive food industry, a tax on clothing will, *ceteris paribus,* make owners of land better off because the price of land would increase relative to the price of labor. However, in the n-dimensional case, it is not possible to know beforehand, in the absence of complete information, which factors will benefit from a shift in demand, simply because it will not be known to which industries spending will be transferred.

Our knowledge of incidence for any "real" economy now appears to very slight indeed. We do know, however, that excise taxes exert benefits as well as burdens on individuals; and we are also aware of the main factors involved in the spread of the benefits and burdens of an excise tax in a competitive economy. The foregoing observations further suggest that more specific results concerning the incidence of excise taxes can be obtained for those cases in which additional appropriate assumptions regarding the shapes of the relevant parameters (preference functions, production functions, relative size of industry taxed, etc.) can be made in such a way as to eliminate the general equilibrium consequences of these taxes and confine their effects to definite individuals, or groups of individuals, in the economy. For example, the long-established theorem of partial equilibrium analysis that the burden of an excise tax on a particular commodity will be divided among the consumers and producers of the taxed commodity according to the elasticities of supply and demand requires only the additional assumption that the taxed industry is so small that the prices of all *other* commodities and the prices of *all* factors do not change.[14]

[14] For statements of this theorem, *cf.* Edgeworth, *op. cit.,* pp. 48-53; Marshall, *op .cit.,* pp. 413-15; J. F. Due, *The Theory of Incidence of Sales Taxation* (New York, 1942), pp. 17-53. For a somewhat different example of the complementarity between the more established types of excise tax analysis and the analysis presented in this paper, *cf.* J. A. Stockfisch, *op. cit.*