1. Introduction : (c) Welfare Economics in an Economy with Production

The Edgeworth box depicted an economy in which the only activity was the division of a fixed quantity of consumption goods among different consumers. There was no production. Of course, producing goods and services is a pretty important economic activity. If we are concerned about efficiency, we should also be concerned with what goods and services get produced, and how.

If we have production, there are additional conditions for efficiency, besides equality of all consumers' MRS's. That condition from the last section — that each person's MRS between any two goods should equal the MRS of any other person — still is necessary for the total supply of goods and services to be allocated efficiently. When we have some influence on the production of goods and services, we also want the total supply of goods and services to be as large as possible. That is, if our production of food and clothing is efficient, then there should not be some other feasible production plan which would produce both more food and more clothing. This condition, that there be no way of producing more of each good and service, is sometimes called "efficiency in production". A production plan will satisfy this condition only if the ratio of the marginal products of different factors of production is the same in each industry. That is, let MP_L^x be the marginal productivity of labour in food production, the number of units of food added by employing one more person–hour of labour, and let MP_K^x be the marginal productivity of machinery in food production. Then efficiency in production requires that labour and machinery be allocated to the food and clothing industries so that

$$\frac{MP_L^x}{MP_K^x} = \frac{MP_L^y}{MP_K^y}$$

Why does this equation describe an efficent division of labour and machinery between the food and clothing industries? The short answer is : "check this out in an intermediate micro text, such as Varian's or Nicholson's". A slightly longer answer is to consider how we divide the fixed total quantity of workers' hours, and the fixed total quantity of machinery, among industries. Allocating more labour to the food industry means more food gets produced, but it also means there is less labour to allocate to the clothing industry. The whole issue — allocating labour and machinery to the food and clothing industries — can also be represented in (another) Edgeworth box. Here the dimensions of the box are the total quantities of labour and machinery available. We measure allocation of labour and machinery to the food industry from the bottom left, and allocations of labour and machinery to the clothing industry from the top right. Instead of indifference curves, we now put in **isoquants** for each industry. An isoquant for the food industry is a bunch of combinations of labour and machinery which can produce a given quantity of food. Moving down the isoquant means substituting labour for machinery in food production, leaving constant the total quantity we can produce of food (if I am measuring labour on the horizontal and machinery on the vertical). The slope of each isoquant is (minus) the ratio of the marginal products of the two inputs : MP_L^x/MP_K^x in the x industry.

Similarly, allocation of labour and machinery to the clothing industry is measured from the top right. There are also isoquants for clothing production, sloping down, and again representing the possibilities of substitution of one input for the other in clothing production : moving up and to the left means using a more labour–intensive method of production of clothing, since it involves more labour and less machinery in the clothing industry. As in the earlier exchange economy Edgeworth box, if the isoquants for the two industries cross, that means that there is a way of producing more of each good. For example, if at some point in the Edgeworth box the isoquant for clothing production were steeper than the isoquant for food, then moving up and to the left (reallocating more machinery to the food industry and more labour to the clothing industry) would produce more of both goods, using the same total quantity of labour and machinery. Only if the isoquants for the two industries are tangent to each other will it be impossible to produce more food without producing less clothing.

Again, as with efficiency in consumption, there is a whole set of allocations of labour and machinery to the food and clothing which are efficient in production. Again, moving from one such allocation to another will mean more food production and less clothing production. Again, as long as the firms producing food and clothing face the same prices for labour and machinery as each other, then this condition will be satisfied under perfect competition.

When goods and services are produced from inputs (such as land and labour and resources), then, I have two sets of efficiency conditions — so far. Efficiency in consumption means that the stock of food and clothing we produce must be allocated efficiently to consumers. This condition holds if each person's MRS between food and clothing is the same as any other person's. Efficiency in production means that we cannot produce both more food and more clothing from our given stock of inputs. It holds if the **marginal rates of technical substitution**, or the ratio of the marginal products of the different inputs, are the same in the production of food as in the production of clothing.

There is one more efficiency condition when there is production. How much more clothing could we make, if we devoted fewer resources to food production? Shifting one person–hour of labour from food production to clothing production would raise clothing production by MP_L^y, and lower food production by MP_L^x. So the rate at which we can substitute clothes for food in production, called the **marginal rate of transformation**, is

$$MRT = MP_L^y / MP_L^x$$

Now if we have efficiency in production then it is also true that

$$MRT = MP_K^y / MP_K^x$$

so that it really does not matter which inputs we transfer. The MRT is the slope of the "production possibility frontier", which shows the trade–off in production between food and clothing. This curve shows the combinations of food and clothing which we can produce, by using our inputs efficiently. Its slope is the rate at which we can trade food for clothing. If our overall choice of production plan is efficient, then this rate must be the rate at which we **want** to trade food for clothing. That is, our production plan is "overall efficient" if

$$MRS = MRT$$

which is my third and final type of efficiency condition. Again, if firms all face the same prices for inputs, and if all firms behave competitively in output markets, then this condition will be satisfied under perfect competition.

So accounting for the possibility that goods and services are not just given to us, but are produced using inputs, does complicate the characterization of efficiency. But it does not alter the relationship between efficiency and equilibrium. It also does not alter the relationship between efficiency and equity. There are a lot of efficient allocations. Moving from one efficient allocation to another makes one person better off while making some other person worse off. As long as we can simply redistribute endowments — of food, or clothing, or inputs to production — from one person to another, we can move from one efficient allocation to another.