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## Environment Production Factor's Demand and Supply

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### Abstract

Since the concept of environment production factor proposed, it has been widely concerned. However, it is lacking for the study on its supply, demand curve and price setting model. Several questions have been discussed in this paper. First, we analyze the supply curve without considering reserved self- using. Second, according to its concept and characteristics, we get its "vertical ladle" supply curve in practice. Finally, combine the demand curve of environment production factor; we get its equilibrium price under condition of perfect competition.

**Keywords:** environment production factor, supply curve, equilibrium price

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### INTRODUCTION

With the development of the age, the content of production factors is becoming richer; it has developed from initial dualistic production factors to pluralism system. The environment, here it is especially refer to the environmental capacity that holding rejectamenta, as exiguous and absolutely necessary for production, has been involved into the theoretical framework of production factors (Tang 2003). Environment production factor involved in production with changing the composition, quantity and structure of its material structure, it will determine the location and shape of the production possibility curve (Dong 2007). Its market price is the basic determining factor of the curve. From the supply and demand, this article discusses the determining of the environment production factor's price.

### THE MARKET SUPPLY OF ENVIRONMENT PRODUCTION FACTOR

#### The Characters of Environment Production Factor

Environment production factor on economics is the environmental capacity that has the ability to accommodate rejectamenta. In form, it includes gaseous, liquid and solid environmental capacity (Li et al. 2017). Similar with land (the traditional factor of production), the environment production factor also have characters of "primitive" and "indestructible" (Guo and He 2002). Say it is primitive, because it can not to be produced. Although people have started to

rebuild and keep the balance of natural ecology, and they have achieved some results, but that just can only be described the restoration of original environmental capacity, but not a new creation. Say it is indestructible, as it will not be reduced in quantity. Or to say that the "original supply" of environment production factor is fixed, its will not change with its price fluctuate. Of course, the fixed of environment production factor supply is relative. If human beings continue to pursuit economic development with sacrifice the environment, the environment production factor will disappeared on one day, and that day will be the end for human being. However, to be simple, this article will not consider the quality's change, and assume it is fixed, and at the basic of this to study environment production factor's "market supply and demand" different with the natural supply".

#### Supply Curve of Environment Production Factor

As a production factor, environment capacity mainly contains the supply, the demand and its price. Currently, the service price of the environment production factor has embodied in the field of emission permits that is "price of emission permits". As said earlier, the "original supply" of environment production factor is fixed, its will not change with its price fluctuate. Now, we should to consider the supply of emission permits: whether it has no relationship with its price?

To answer this question, the follow still begin with a single owner of emission permits. Assuming the

owner of emission permits is a consumer; his purpose of behavior is maximizing utility (Wu et al. 2017). During a period, the quality of emission permits he used is fixed and limited (Berge 2016). Similar as other traditional factors (such as land, labor and capital), the problem which the owner needs to solve is: how to get the most effectiveness with the fixed emission permits during reservation and the supply market.

Similar with land supply (Gao 2007), providing emission permits does not directly increase effectiveness. The owner supply emission permits is to gain income, and the charges for disposing pollutants can be used for various consumer purposes to increase effectiveness. Therefore, the owner actually takes choice during the potential income of emission permits supply and reservation. His utility function can be written like this:

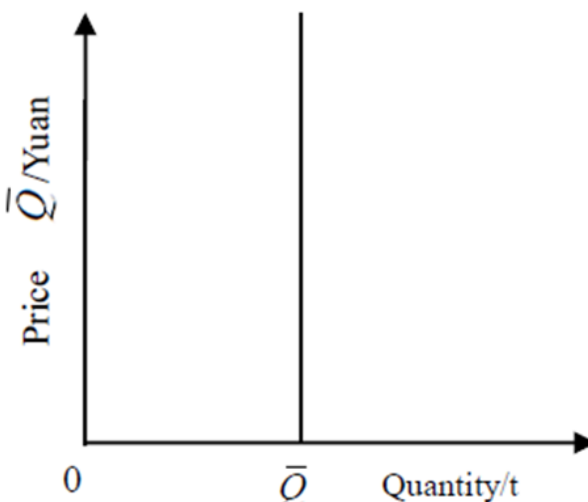
$$U = U(Y, q) \tag{1}$$

There, Y is emission permits trading income and q is the quantity of reserved emission.

The problem now is that how the reserved emission increase effectiveness for the owner. Clearly, if not used to supply in the market, the emission permits can be used to build ecological zones or keep the balance of soil and water resource. These consumptive uses of emission permits obviously increased the owner's effectiveness, just as the role of laborers' leisure. But generally speaking, the consumptive of emission permits can only occupy the use of emission permits in a very small portion in total; unlike the use of consumptive time occupy a large part in all time. If assuming not to consider the tiny part of consumptive emission permits, that is not to consider the consumptive emission permits' effectiveness, then the marginal utility of consumptive emission permits is zero. Thus the utility function simplifies like this:

$$U = U(Y) \tag{2}$$

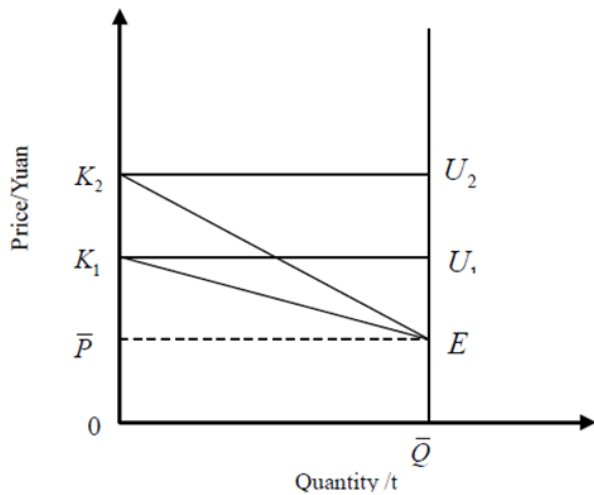
In other words, the effectiveness just depends on the trading income of emission permits, and has nothing with the quality of reserved emission. In this case, in order to get the maximize effectiveness; we must to make the income of emission permits' bargain into maximized (as effectiveness is always the incremental function for the income). And in order to maximize the emission permits' bargain income also requested to supply as much as possible. (Assuming the emission permits' price is always positive. As the emission permits that the owner owns is fixed, such as is  $\bar{Q}$ , so he



**Fig. 1.** The environment production factor supply curve only used in production

will supply  $\bar{Q}$  emission permits regardless how much it is. Thus, the supply curve of emission permits is in the between of the vertical and at the position of  $\bar{Q}$ . See **Fig. 1.**

The same conclusion can also gained by analysis of no variant continuous, see **Fig. 2.** The horizontal axis Q that is the quantity of reserved emission permits, the longitudinal axis Y is the income of emission permits. The emission permits owner's initial state E indicate that his no- emission permits income is  $\bar{Y}$ , and the quantity he owned in total is  $\bar{Q}$ . The two budget lines  $EK_1$  and  $EK_2$  respectively correspond to two situations that the price for emission permits is  $R_1$  and  $R_2$ , that is  $K_1 = \bar{Q}R_1 + \bar{Y}$ ,  $K_2 = \bar{Q}R_2 + \bar{Y}$ . The special place in the figure is the no variant continuous: they all are parallel straight lines, for example  $U_1$  and  $U_2$ . No variant continuous is parallel, this indicates the owner's effectiveness just depend on the emission permits' income not on the reserved emission. For example, on the straight line level  $U_1$ , the income at every dot is equal. Therefore, they are no different, despite their reserved emission are different. Similarly, the higher no variant continuous indicate higher effectiveness, like  $U_2 > U_1$ . This is because the former's income is higher than the latter. Clearly, the special shape of no variant continuous cluster is the visual image when emission permits have no reserved self-use.

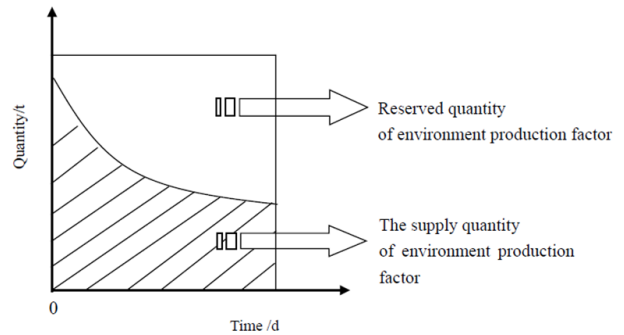


**Fig. 2.** No variant continuous analysis of environment production factor

The horizontal no variant continuous cluster indicates: regardless how the emission permits' price changed, the optimization reserved emission is always 0, thus the supply of emission permits in total is always  $\bar{Q}$ , that is the whole emission permits resource of the owner. For example, assuming the price is  $R_1$ , the budget line is  $EK_1$ , now the most effective combination or equilibrium point obviously is  $K_1$ , because it is the greatest effectiveness of the points  $U_1$  under the conditions of  $EK_1$ . Correspond to point  $K_1$ , the optimization reserved emission is 0, thus the optimization resource corresponding to emission permits supply still is 0, then the supply still is  $\bar{Q}$ . In other words, the supply of emission permits is always  $\bar{Q}$ , it has nothing with price, so the emission permits supply curve is vertical.

It is worth noticing that the conclusion of emission permits supply curve is vertical is not because of natural environment factors' quantity is fixed, but the assuming that emission permits have only one purpose-production and no self-purpose. If emission permits are only productive, the supply curve is vertical certainly.

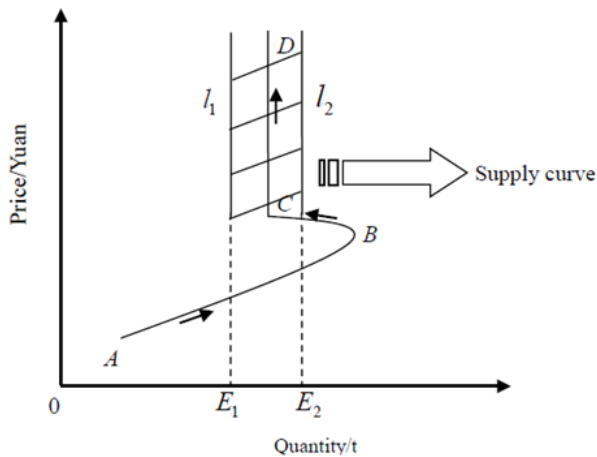
This shows that the fixed of emission permits' quantity could not explain its supply curve should be vertical. To make it vertical, we must assume that the emission permits have no self-purpose, no self-value, or to say their chance cost in productive use is 0. This assumption is clearly not fully according to reality, because the environment production factor also has consumptive use. According to current global situation of the pollution and the trend of social development, the intensity of actions on environmental protection will be increased year by year. Therefore, the environment production factor supply will gradually decline with



**Fig. 3.** The supply of environment production factor will gradually decline year by year

times, and put apart sufficient capacity to self-recovery ecological environment, establish natural ecological protection zones and meet the development trend of green economy. See **Fig. 3**.

Synthesis the production use and reservation use of environment production factor, its supply curve shows like a "vertical ladle", see **Fig. 4**. This is because, despite in long-term, the total environment production factor supply is fixed, but in a certain period of time, the price fluctuates will continue to influence the environment production factor supply; the supply will rise up with price rising, as shows in **Fig. 4**: AB. With the increase of supply, environment production factor supply will reduce in total, therefore, even though the price continues to rise, but the supply is reduced, just as the BC in **Fig. 4**. The environment production factor supply changes from A to B then to C, as on the one hand is influenced by the total supply, and on the other hand is the result of the government's macroeconomic regulation and control. After this turning, to achieve maximum efficiency, we must reduce the environmental costs, and also will experience changes from extensive operation of high energy-consuming low output to intensive management that saving energy to reducing consumption. Therefore, to CD in **Fig. 4**, even if prices continue to rise, but environment production factor supply will not change. The supply of this curve is not a fixed numerical value, but a relatively stable interval [E1, E2]; indicate that the supply is stable in a certain interval.



**Fig. 4.** The supply curve of environment production factor

**THE MARKET DEMAND OF ENVIRONMENT PRODUCTION FACTOR**

**The Characters of Environment Production Factor Demand**

The demand of the environment production factor means that: during a certain period, and at a certain price level, the quantity that consumers will and able to buy. Similar with the concepts of traditional production factors, the demand of environment production factor is the quantity that consumers will and able to buy, not the actual purchased quantity. It is also an effective demand, not just consumers' subjective wishes (Ping and Rubin 2006).

**The Demand Function and Curve of Environment Production Factor**

In the above analysis, the factors that influence environment production factor's quantity are independent variable; the demand quantity is dependent variable. The function expression is as follow:

$$Q_d = f(P, P_r, Y, E) \tag{3}$$

There,  $Q_d$  is the demand quantity of environment production factor;

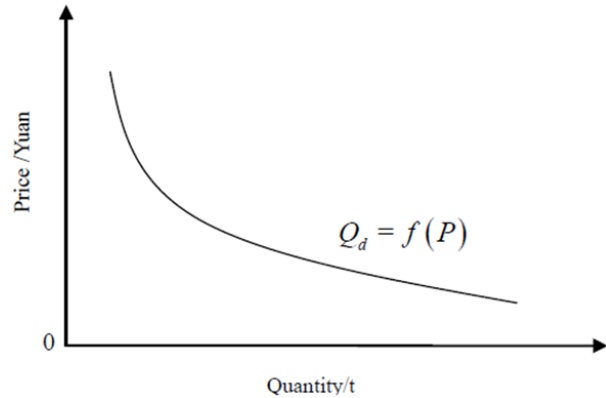
$f$  is the function;

$P$  is the price of environment production factor ;

$P_r$  is the price of other production factors;

$Y$  is the income level of consumers;

$E$  is the expectation of consumers in the future.



**Fig. 5.** The demand curve of environment production factor

However, if analysis all factors that influence environment production factor at the same time, the problem will become complicated. In order to get a clearer purpose, we can focus on one factor and make others unchanged. As price is the most basic factor to the demand, so we assume other factors are remain unchanged, just analysis the price influence, going to make the environment production factor demand as a function of its price. The function is this:

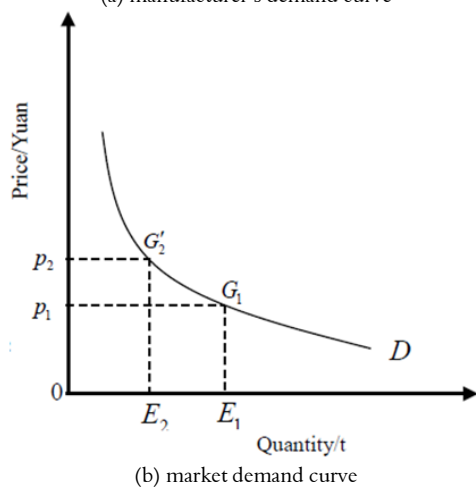
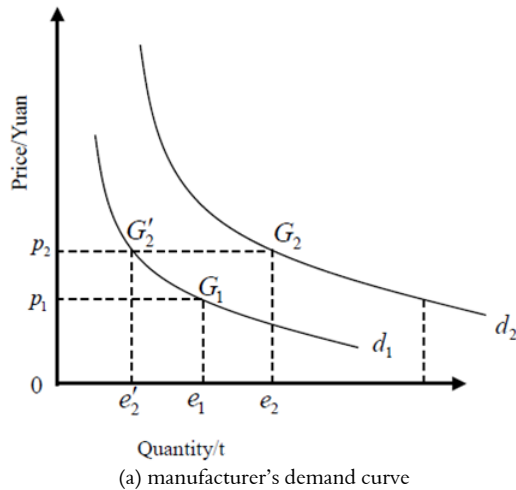
$$Q_d = f(P) \tag{4}$$

The demand function  $Q_d = f(P)$  indicates the demand of environment production factor and its price have a relationship one-to-one, and the relationship can be indicated by demand curve.

In **Fig. 5**, the horizontal axis is the quantity of environment production factor; the vertical axis is the price. The demand of environment production factor increases with prices decrease.

**THE MARKET EQUILIBRIUM OF ENVIRONMENT PRODUCTION FACTOR UNDER CONDITION OF PERFECT COMPETITION**

The supply and demand of elements market is the summation of all individual manufacturers'. Adding the individual supply and demand is a complex process. Because if all manufacturers increase or decrease production at the same time, the price will change, then the supply and demand of elements will be affected. The equilibrium of elements is similar with the production market, the demand curve and supply curves intersect, to determine the equilibrium quantity and price. The difference is that the demand for products depends on the marginal effectiveness; but the

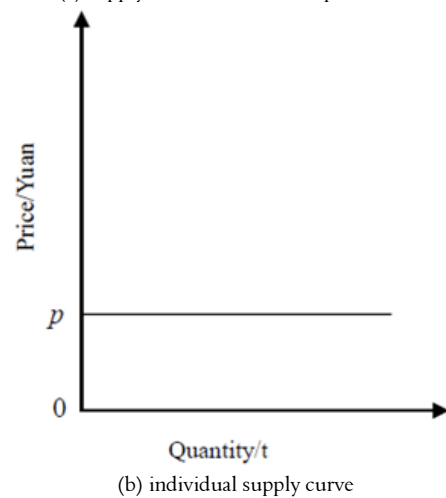
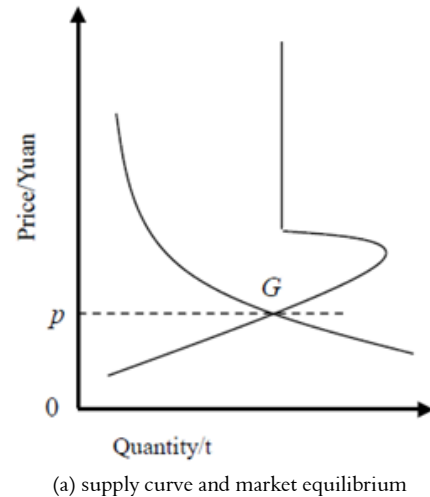


**Fig. 6.** Demand under condition of perfect competition

demand of elements depends on marginal production income.

**Fig. 6(a)** is under the condition of production market and element market both are perfect competition, manufacturer's demand curve due to a fluctuant element. If the market price of the fluctuant element is  $Op_1$ , the manufacturer use  $Oe_1$  units, the total all manufacturers used is  $OE_1$ , that form point  $G_1$  on **Fig. 6(b)** - market demand curve.

Suppose that the price of environment production factor rise from  $Op_1$  to  $Op_2$ , and other conditions remain unchanged, the manufacturer should use  $Oe_2$  units follow demand curve  $d_1$ . But, other conditions can not remain unchanged. So when all manufacturers reduced production under the condition of elements price rising, production price consequentially to be risen, and the demand curve of fluctuant elements will be risen too, as from  $d_1$  to  $d_2$ . This shows that, when fluctuant element price rise to  $Op_2$ , manufacturer will use  $Oe'_2$  units rather than  $Oe_2$  units. Then to sum all  $Oe'_2$  of all manufacturers can gain  $G_2$  on the demand

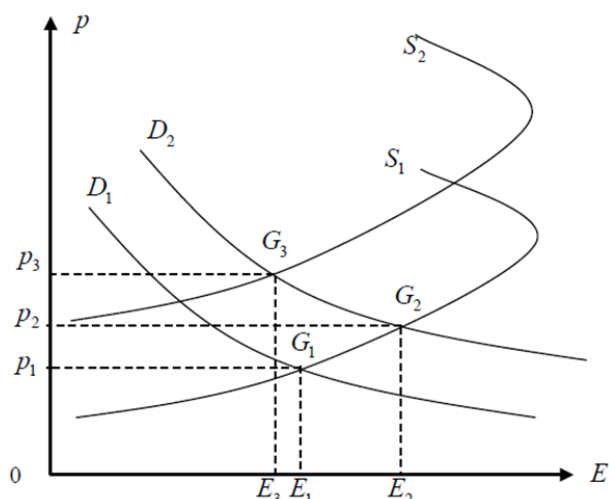


**Fig. 7.** The market equilibrium under condition of perfect competition

curve of **Fig. 6(b)**. Therefore, as long as change price of the element, we can get any number of dots  $G_n$ , connect the points, we could get the market demand curve D.

The market supply curve of fluctuant element is different with individual fluctuant element. **Fig. 7** shows that: under the condition of perfect competition, as the price is fixed, the supply curve that manufacturer facing is a horizontal line, see **Fig. 7(b)**, and the whole market supply curve is the sum of all elements owners' supply curves, it general inclines from lower left to higher right and has positive slope. See **Fig. 7(a)**. This is not only due to the higher price the more supply, but also the higher elements' prices can attract other elements of other industry into this industry, greatly increased elements supply.

With the market demand curve and market supply curve, we can get the element equilibrium price under condition of perfect competition. See dot G in **Fig. 7(a)**. The equilibrium condition is:



**Fig. 8.** The market equilibrium under condition of the complete monopoly market

$$VMP = MRP = MFC = AFC \quad (5)$$

The above analysis of environment production factor is under the condition of perfect competition. In fact, the environment production factor market competition is not perfect, especially in China where the economic foundation under condition of public ownership, where environment production factor often be looked as public resources and appear in the complete monopoly market.

Environment production factor is different from labor or capital, its property rights belong to the state; therefore, the environment production factor market is a complete monopoly market. In this condition, the price of environment production factor changes as follows:

Firstly, the demand of environment production factor will increase following the rising manufacturers' number. See **Fig. 8**, when the demand curve rises from  $D_1$  to  $D_2$ , the environmental element price rises from  $Op_1$  to  $Op_2$ , and the using quantity increases from  $Op_2$  to  $Op_3$ .

Secondly, with the propaganda of environmental protection organizations, the government reduce environment factors supply, especially for some regions where original environment preserved better, they will limit environment factors' supply. **Fig. 8** shows that: when the environment factors' supply reduces from  $S_1$

to  $S_2$ , the using quantity of environment factors reduce from  $OE_2$  to  $OE_3$ , and environment production factors' prices rise from  $Op_2$  to  $Op_3$ .

**Fig. 8** shows that: in reality situation, environment production factors' price is gradually rising. But under the equilibrium price, the using quantity of environment production factor is in a declining trend. This is in line with the principle of overall control, and also implies the essential requirements for sustainable development. Of course, the price rising is not unlimited; in actual operation, environment production factors' price should be slightly higher than the average marginal cost that manufacturer's consumption in environmental governance.

### CONCLUSION

Through analysis the supply and demand situation of environment production factor, under different market conditions, the equilibrium is different. Due to the self-characteristics of environment production factor, the supply curve shows like a "vertical ladder", and demand curve is similar as other factors shows as a smooth curve inclined from left to right. When environment production factors' supply close to the lower-point that controlled by the total environment production factors, the supply could not increase. The environment production factors' price rising up make manufacturers cannot but to reduce consumption of environment factors, and supersede by technical factors and management factors, eventually achieve market-oriented protection for the environment. The environment production factors' price is gradually rising, but the using quantity under the equilibrium condition is in a declining trend. Of course, the price rising is not unlimited, in actual operation; environment production factors' price should be slightly higher than the average marginal cost that manufacturer's consumption in environmental governance.

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