Externality in the Theory of International Trade: Some Basic Concepts

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Abstract

This paper introduces some basic features of externality. Emphasis is given to the analysis of externality in the theory of international. It also discusses about the right government policies to correct externality.

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1 Introduction

Externality has long been a very important topic in the economics literature. In the theory of international trade, a lot of work has been given to the analysis of closed and open economies with externality. In this short note, we provide a discussion of the nature of externality and examine some of its implications, with an emphasis on how it is treated in the theory of international trade. This note also helps clarify some of the argument in the three accompanying papers, Wong (2000a, 2000b, and 2000c). However, this note is not meant to be an extensive survey of the theories and results. For more discussion of the fundamental concepts of externality, see a recent survey in Cornes and Sandler (1996).

What is externality? Quite a number of concepts have been suggested in the literature, and some have argued about when and where externality exists. Here, we use an concept that is common in the trade literature. We say that an action creates externality if both of the following two conditions are satisfied: First, it affects the economic environments that other agents are facing, and second, it is not fully compensated or penalized for. The latter condition explains why this approach is taken here: If an action that affects others is not fully compensated or penalized for, the amount of the action taken by agents may not be the same as what the society wants. In other words, externalities imply misallocation of resources, and some corrective policies may have to be taken by the government. We will have more discussion of resource allocation and policies later in this paper. For the time being, we can use some examples to bring out the meaning of externality.

Consider the purchase of a product by a consumer. The purchase will lower the existing stock of the product, and will have an upward pressure on the price of the product. All other consumers who intend to purchase the product will be affected adversely. As a result, the first condition for externality is satisfied. However, should it be regarded as externality? The answer is no so long as the market price the consumer pays is equal to the social marginal cost. The reason is that the initial consumer is paying the full price (social marginal cost) of the unit of the product. As a result, the purchase does not represent a resource misallocation and does not call for policy intervention. For the same reason, no externality and resource misallocation will be generated when a foreign worker immigrates into an economy, receiving the market wage rate that is the same as the marginal product of labor.

Let us consider another example. A car on a highway will create externality if the presence of the car has an (negative) impact on the traffic: the existence of externality is due to the fact that driving the car on the highway makes the highway more congested and that it is not adequately penalized for creating the problem.

In this example, both conditions for externality are satisfied.[1] Another example is the so-called network externality: the utility of a user of products like telephone increases with the number of users. A person X can get higher utility from the use of a new telephone because he can now call his friends, but his use of telephone also increases the utility of X's telephone-using friends who now are able to contact X by telephone. However, people rarely receive compensation from their friends who are already telephone users for joining the telephone network, even though their friends get a higher utility. It is the absence of such compensation (or any corrective policies) that people do not receive adequate incentive to join the telephone network.

From the last two examples of externality, we can see why externality has implications on the allocation of resources. In the traffic example, because driving cars on highways is not associated with an adequate penalty for worsening the traffic, people tend to drive too often on highways.[2] In the telephone network example, the number of telephones will be less than what the economy should have because people do not take into account its positive impacts on the utility of those people who may call them.[3]

This note is for those who are not familiar with the concept of externality and with how externality is analyzed in the theory of international trade. We will be more explicit about how externality may affect some of the theorems of international trade and factor mobility in the accompanying papers (Wong, 2000a, 2000b, and 2000c). Section 2 will focus on various types of externalities that affect the production side of an economy. Section 3 will examine the implications of externality on resource allocation and discuss some policies for the government.

2 Types of Externality

If we dichotomize an economy into the production side and the consumption side, we can identify four types of externality, depending on which part of the economy generates externality and which part of the economy is being affected. In the theory of international trade, those externalities that affect the production side of the economy are more important and have received more attention. As a result, this note focuses on

[1] Of course the driver does have to pay a price to drive on the highway: price of fuel and time spent. As long as the driver does not have to pay extra for driving on the highway, he/she does not bear the cost of traffic congestion.

[2] Alternatively, we can say that should drivers pay an adequate price in order to be able to drive on a highway, less cars will be expected.

[3] We can say that there is negative externality in the first example, and positive externality in the second example.

production-side externalities. Consumption-side externalities, which can be analyzed in the same way, will not be covered.

Consider an economy with m factors and n sectors. Suppose that the production function faced by firm f in sector i, $i \in [1, n]$, is given by

$$Q_i^f = F_i^f(\mathbf{v}_i^f, \mathbf{W}_i), \tag{1}$$

where Q_i^f is the output of the firm, $\mathbf{v}_i^f$ is the vector of inputs employed by the firm, and $\mathbf{W}_i = (W_i^1, W_i^2, ...)$ represents a vector of all other variables that affect the output of the firm. The vector $\mathbf{W}_i$, which represents externalities, has the following properties: The values of all variables in the vector are regarded as constant by all firms, or cannot be controlled by the firms, and how $\mathbf{W}_i$ may affect Q_i^f is neglected by those agents who directly control the values of the variables of $\mathbf{W}_i$. Treating $\mathbf{W}_i$ as parameters, function $F_i^f(.,.)$ behaves like a neoclassical production function: It is concave, continuous, increasing, and linearly homogeneous in all factor inputs. Firms will treat $\mathbf{W}_i$ as constant, or believe that individually they cannot affect the values of the elements in $\mathbf{W}_i$. They choose inputs to maximize an objective function (such as its profit).[4]

Factor k of the externality vector, W_i^k, has positive externality on Q_i^f if

$$\frac{\partial F_i^f}{\partial W_i^k} > 0. \tag{2}$$

The externality of factor W_i^k on the output Q_i^f is negative if the partial derivative in (2) is negative, or no externality exists if the partial derivative is zero.

In the trade literature, some additional assumptions are made in order to define a sectoral production. First, all firms in the same sector are assumed to have identical technologies. In other words, the production function in (1) applies to all the firms. With this assumption, condition (1) reduces to

$$Q_i^f = F_i(\mathbf{v}_i^f, \mathbf{W}_i). \tag{3}$$

Second, recall that the production function in (3) is linearly homogeneous in $\mathbf{v}_i^f$. Treating $\mathbf{W}_i$ as given, all firms perceive that the technology they are facing are

[4]Note that we assume that the externality factors affect all the firms in the same sector in the same way. A more general model in which different firms in the same sector are affected differently by the same externality factors can be considered, but it will need a more complicated analysis.

subject to constant returns. Third, all sectors are competitive in the sense that all agents are price takers and have no monopoly power.[5]

To illustrate the above point further, let us derive the marginal product of factors. Using (3), the (private) marginal product of factor j in firm f of sector i is equal to

$$PMP_{ij}^f = \frac{\partial F_i}{\partial v_{ij}^f}. \tag{4}$$

In (4), the partial derivative is evaluated with all other factors and all the elements of $\mathbf{W}_i$ held constant. The marginal product in the condition is also called *private marginal product*, which is evaluated under the condition that $\mathbf{W}_i$ is held constant.

To maximize the profit, the firm employs factor j, $j \in [1, m]$, until the value of its marginal product is the same as the market price of the factor, w_j, i.e.,

$$p_i \frac{\partial F_i}{\partial v_{ij}^f} = w_j, \tag{5}$$

where p_i is the market price of good i. Multiple both sides of (5) by the level of employment of factor j by the firm and sum over all employed factors. We have

$$p_i \sum_j \frac{\partial F_i}{\partial v_{ij}^f} = \sum_j w_j v_{ij}^f. \tag{6}$$

Recall that function $F_i(\mathbf{v}_i^f, \mathbf{W}_i)$ is linearly homogeneous in $\mathbf{v}_i^f$, with $\mathbf{W}_i$ held constant. Making use of this property, (6) reduces to

$$p_i Q_i^f = p_i F_i(\mathbf{v}_i^f, \mathbf{W}_i) = \sum_j w_j v_{ij}^f. \tag{7}$$

RHS of (7) is the revenue of the firm and the LHS is its total cost. Condition (7) thus means that the profit of the firm is zero, which is the long-run equilibrium of a competitive firm. An implication of this result is that the present formulation of externality is compatible with perfect competition.[6]

With the above assumptions, we can derive the sectoral production function. First, note that since all firms have the same technologies, there is no harm to assume that all firms make the same production decision; the same amounts of inputs and output.

[5]Kemp and Shimomura (1995) argue that there are cases in which all identical firms will act jointly as a monopolist to maximize the total profit and thus each individual firm's profit.

[6]The present formulation is sometimes called the Marshallian externality (Marshall, 1879, 1890).

Let there be n_i firms in the sector.[7] Therefore the total output of the sector can be expressed as

$$\begin{aligned} Q_i &= \sum_f Q_i^f = n_i Q_i^f = n_i F_i(\mathbf{v}_i^f, \mathbf{W}_i) \\ &= F_i(n_i \mathbf{v}_i^f, \mathbf{W}_i) = F_i(\mathbf{v}_i, \mathbf{W}_i), \end{aligned} \tag{8}$$

where $\mathbf{v}_i = n_i \mathbf{v}_i^f$ is the vector of all inputs in the sector. In deriving condition (8), the fact that function $F_i(.,.)$ is linearly homogeneous has been used. Condition (8) gives the sectoral production function. Note that the private marginal product of a factor in the sector derived from the sectoral production function is the same as the one for each firm given by (5).

Condition (8) is general in the sense that the types of externality have not been specified. In the trade literature, very often only one type of externality is considered at a time. The following types of externality can be identified.

1. *Output-Generated Externality.*

In this case, the vector $\mathbf{W}_i$ contains only the output levels of some sectors. In particular, if Q_i is included, then own-sector externality exists, and if any of other outputs is included, then cross-sector externality exists.

An example of own-sector externality can be given. Suppose that a ground shipping company has only two types of inputs, truck and driver, and its business is to ship by trucks certain commodities from location A to location B along a highway. The traffic condition on the highway affects the efficiency of truck transportation. Taking the traffic condition as given, each company believes that it is able to, say, double its business by doubling the number of trucks and drivers. As a matter of fact, if a company does increase the number of trucks and drivers used in the business, it has a negative impact on the traffic condition. In other words, negative own-sector externality is created.

2. *Input-Generated Externality*

In this case, the vector $\mathbf{W}_i$ contains the quantities of some of the inputs in certain sectors. One example can be provided to illustrate this type of externality. Suppose

[7]Note that with constant returns and perfect competition, the number of firms in a sector is not important.

that firms in a sector provide free training courses to new coming workers. After such a training course, a worker becomes more skilled and productive. However, a firm usually pays the trained worker a wage rate lower than the marginal product of the worker so as to recover the costs of the training course (including possibly also the wage paid to the worker while he is receiving the training). Unless there is a enforcable contract that binds the worker to the firm for a certain period of time, the worker will have an incentive to move to other firms. These firms, which have not paid for the costs of the training course, are willing to pay a wage equal or close to the marginal product of the worker. As a result, worker training courses paid for by firms without any adequate binding contracts will create externality. In this example, $\mathbf{W}_i$ includes the number of training courses provided by other firms (in the same sector and possibly those in other, relevant sectors), and this externality directly affects the productivity of the workers a firm hires.

Output-generated externality is related to input-generated externality. Since output is produced by inputs, if a firm producing output will create externality, then employment of any of the inputs that will increase output will also create externality. However, input-generated externality refers to the fact that the employment of some of the inputs of a firm will create externality but not the employment of some other inputs. In the example described above, worker training courses may create externality, but for machines, a similar training course (such as installation, fine tuning, and so on) will not create externality because a machine cannot move to another firm. (The first condition of externality is not satisfied.)

3. *Consumption-Generated Externality*

In the presence of this type of externality, the vector $\mathbf{W}_i$ consists of the consumption levels of various commodities (aggregate consumption levels or the consumption by certain agents). Let us consider an example. Suppose that a company develops a recreation park by a river. The park includes facilities for swimming, canoeing, water skiing, and other water activities. Suppose further that large scales of water activities in the park adversely affect the hatching of fish like salmon. This causes a drop in the production of salmon. Note that the park may or may not create externality, depending on how much rent or land price the company pays for developing the park and whether other parts of the economy (such as the fishermen) are adequately compensated for the drop in salmon production. However, if the initial landlord of the land of the park is a private one and has nothing to do with salmon fishing, the rent or land price charged will probably not be adequate to compensate for the drop in salmon production.

3 Own-Sector Externality

Own-sector externality receives the most attention among all types of externality in the trade literature. Here we provide more analysis of it.

With own-sector externality, the sectoral production function (8) reduces to

$$Q_i = F_i(\mathbf{v}_i, Q_i). \tag{9}$$

The *private marginal product* of factor j, $j \in [1, m]$, is equal to

$$PMP_{ij} = \frac{\partial F_i}{\partial v_{ij}}.$$

For cost-minimizing, firms hire factor j until the price of the factor, which is positive, is equal to the value of marginal product of the factor. This implies that the PMP must be positive. The *social marginal product* of factor j, however, is the total effect of a marginal increase in the employment of factor on the sector's output, i.e.,

$$SMP_{ij} = \frac{\partial Q_i}{\partial v_{ij}} = \frac{1}{1 - F_{iQ}} \frac{\partial F_i}{\partial v_{ij}} = \frac{1}{1 - F_{iQ}} PMP_{ij}, \tag{10}$$

where F_{iQ} is the partial derivative of F_i with respect to Q_i. Since $PMP_{ij} > 0$, to have a positive social marginal product, it is assumed that $F_{iQ} < 1$.

Suppose that the production scale is increased by λ times, $\lambda > 1$, i.e., all inputs are increased by λ times. Condition (9) reduces to

$$Q_i = F_i(\lambda \mathbf{v}_i, Q_i) = \lambda F_i(\mathbf{v}_i, Q_i), \tag{11}$$

where Q_i is now the new output level. Differentiate both sides of (11) and rearrange terms to yield

$$\frac{\partial Q_i}{\partial \lambda} = \frac{F_i}{1 - \lambda F_{iQ}}. \tag{12}$$

Making use of (12), the elasticity of scale is shown to be

$$e_i \equiv \frac{\lambda}{Q_i} \frac{\partial Q_i}{\partial \lambda}\bigg|_{\lambda \to 1} = \frac{1}{1 - F_{iQ}}.$$

Recall that F_{iQ} is assumed to be less than unity. The following concepts are equivalent:

1. $e_i > (<)\ 1$;
2. the technology of sector i exhibits economies (diseconomies) of scale, or increasing (decreasing) returns;
3. positive (negative) externality exists;
4. $F_{iQ} > (<)\ 0$.

Assuming that the derivative of $F_i(\mathbf{v}_i, Q_i)$ does not vanish, the function in (9) is inverted to give

$$Q_i = G_i(\mathbf{v}_i). \tag{13}$$

Note that the partial derivatives of $G_i(\mathbf{v}_i)$ with respect to factor j is the social marginal product of the factor, i.e.,

$$SMP_{ij} = \frac{\partial Q_i}{\partial v_{ij}} = \frac{\partial G_i}{\partial v_{ij}}. \tag{14}$$

In the literature, very often some special cases of sectoral production functions are assumed in order to get a mathematically more manageable model. For example, one type of sectoral production function is

$$Q_i = h_i(Q_i)\tilde{F}_i(\mathbf{v}_i), \tag{15}$$

where function $h_i(Q_i)$ satisfies the following assumptions: (a) $h_i(Q_i) = 0$ for $Q_i = 0$, and $h_i(Q_i) > 0$ for $Q_i > 0$; (b) $h_i'(Q_i) > (<)\ 0$ for $Q_i \geq 0$ if positive (negative) own-sector externality exists. In condition (15), $h_i(Q_i)$ is treated by all firms as constant, just like a technology index. Function $\tilde{F}_i(\mathbf{v}_i)$ has the usual properties of a neoclassical function.

Condition (15) can be inverted to give the sectoral production function. This function has an interesting property. Let us first define the elasticity of $h_i(Q_i)$ as the *rate of variable returns to scale* of the sector, $\varepsilon_i \equiv Q_i h_i'/h_i = h_i'\tilde{F}_i(\mathbf{v}_i)$. Note that the sector exhibits increasing (decreasing) returns if and only if $\varepsilon_i > (<)\ 0$. Differentiate both sides of (15) with respect to the employment of factor j and rearrange the terms to give

$$\frac{\partial Q_i}{\partial v_{ij}} = \frac{h_i}{1-\varepsilon_i}\frac{\partial \tilde{F}_i}{\partial v_{ij}}. \tag{16}$$

Recalling the definitions of private and social marginal products of factors, condition (16) can be rewritten as

$$SMP_{ij} = \frac{1}{1-\varepsilon_i} PMP_{ij}. \tag{17}$$

Note that from (16) and (17), in order to have a positive social marginal product of a factor, it is assumed that $\varepsilon_i < 1$.

Consider two factors, j and k, that are employed in the sector. Making use of (17), the marginal rate of technical substitution is equal to

$$MRTS_i^{jk} = \frac{SMP_{ij}}{SMP_{ik}} = \frac{PMP_{ij}}{PMP_{ik}}. \tag{18}$$

Note that since function $\tilde{F}_i(\mathbf{v}_i)$ is linearly homogeneous, the ratio of PMP_{ij} to PMP_{ik} depends only on the ratio v_{ij}/v_{ik}. Condition (18) implies that $MRTS_i^{jk}$ depends only on the ratio v_{ij}/v_{ik}. In other words, the aggregate production function is homothetic in the sense that the slopes of the isoquants at points along the same ray from the origin are constant.

Sometimes a specific functional form of $h_i(Q_i)$ is assumed so that the sectoral production function is written as

$$Q_i = Q_i^{\alpha} \tilde{F}_i(\mathbf{v}_i), \tag{19}$$

where α is a constant assumed to be less than unity. As a matter of fact, it can be shown that α is the rate of variable returns to scale of the sector. Condition (19) can be written as

$$Q_i^{1-\alpha} = \tilde{F}_i(\mathbf{v}_i). \tag{20}$$

The elasticity of scale of the function in (20) is

$$e_i = \frac{1}{1-\alpha}, \tag{21}$$

which is constant. Thus the sectoral production function is homogeneous of degree $1/(1-\alpha)$, which is greater (less) than unity if the positive (negative) externality exists, i.e., if $\alpha > (<)\ 0$.

4 Welfare and Policy Analysis

In the previous sections we analyze the nature and properties of externality. We now examine the following questions: Why is it important to study externality? Are there any policy implications?

4.1 Externality and Resource Allocation

The main reason for analyzing externality is that it has important implications on resource allocation. To see this point, let us recall the distinction between private marginal product of a factor in a sector and its social marginal product. For the time being, let us use the general sectoral production function in (8) to illustrate this idea. Firms, taking the effects of $\mathbf{W}_i$ on their outputs as given, determine the private marginal product of factor j as given in (4). If resource allocation is determined in a market mechanism, firms will choose the amounts of factors to employ based on private marginal products. However, since the firms neglect the effects of $\mathbf{W}_i$ on their outputs, their decisions are most likely different from those based on full recognition of the effects of $\mathbf{W}_i$.

The social marginal product of factor j in sector i, which is based on the total effect of a marginal increase in the employment of a factor on the sector's output, is equal to

$$SMP_{ij} \equiv \frac{\partial Q_i}{\partial v_{ij}} = \frac{\partial F_i}{\partial v_{ij}} + \sum_k \frac{\partial F_i}{\partial W_{ik}} \frac{\partial W_{ik}}{\partial v_{ij}} = \frac{\partial F_i}{\partial v_{ij}} + \phi_{ij}, \tag{22}$$

where

$$\phi_{ij} \equiv \sum_k \frac{\partial F_i}{\partial W_{ik}} \frac{\partial W_{ik}}{\partial v_{ij}}.$$

The variable ϕ_{ij} represents all indirect effects of an increase in the employment of factor j on the output of the sector. In (22), the partial derivative of Q_i requires that only the quantities of other factors are kept constant while the impacts of a change in v_{ij} on $\mathbf{W}_i$ are fully allowed. Comparing (4) and (22), it is clear that the divergence between PMP_{ij} and SMP_{ij} is a measure of the degree of resource misallocation: If ϕ_{ij} is positive (or negative), then from the society's point of view, the firms underestimate (overestimate) the contribution of factor j (from the society's point of view), causing an underproduction (overproduction) of the product.

4.2 Externality, Property Rights, and Transaction Costs

Economists have no problem to accept that the two conditions for externality mentioned in the introduction imply resource misallocation. However, they have different opinions on what to do next. In particular, there are debates about whether in the

private sector there is an automatic mechanism that will improve or even eliminate the resource misallocation so that externality will not exist.

It is beyond this simple note to go over these debates. Interested readers can read, for example, a recent survey in Cornes and Sandler (1996). What we want to do here is to make use of the examples given earlier to illustrate some of these ideas, with an emphasis on the common approaches in the trade literature.

Let us recall the recreation park example described in Section 2. We mentioned that the creation of such a park creates negative externality to the fishing industry because the adverse effect has not been adequately penalized for. This is not the only possibility. Suppose instead that the river is jointly owned by a union representing the fishing companies that fish in that river. In that case, the union can charge a price to the recreation firm for building the park. In this case, recreation firm receives penalty and resource may not be misallocated. There is yet another possibility. Suppose the river is public and the fishing union cannot charge the recreation firm. However, the union may bribe the recreation firm not to develop the park or to shrink the scale of the park. It is then possible that the resources may not be misallocated although the bribes will represent income redistribution.

We can consider also the network example described above. It was argued earlier that because of positive externality telephones may be undersubscribed. However, the positive externality may disappear if new telephone subscribers can charge their friends who are already telephone subscribers an appropriate fee. When receiving enough incentives, no resource misallocation will occur.

It is therefore argued that if property rights can be well defined and/or transaction costs are insignificant, externality will not exist (Coase, 1960). Sometimes, however, the externality problem may be in another market. In the worker training class example, we argue that externality exists because workers may move to another firm after the training. This is not the only possibility. Another one is to have the firms charge the workers for the costs of training. Workers will be willing to pay certain tuition because through training they can become more skilled and get better paid later. The question then is, why do all firms usually not charge the workers for the training? One reason is that some of the knowledge the workers gain in training classes is very firm specific. In this case, firms providing the training classes would not worry that the workers will move to another firm after training because the knowledge received will be useless in other firms. In this case, externality does not exist. Another reason is that unskilled workers cannot afford the tuition, and cannot borrow from banks or friends for the tuition. In this case, the problem is at least partly due to an imperfect capital market.

The above discussion brings out two important points about externality, especially

if one is interested in finding the right government intervention (or no intervention): (a) Externality may not exist if property rights are well defined or if transaction costs are negligible. (b) The problem of externality may originate from another market. If there is an automatic mechanism in the system that correct the externality problem, no government intervention is needed. If the externality problem originates from another market, the government may be able to find a solution by looking at somewhere else.

In the trade literature, many types of externality have been brought out. Usually externality is defined and then taken as given. One justification is that usually the problems involve a large part of the economy so that transaction costs are assumed to be very high. For example, in the traffic problem, there are so many cars involved that affect the traffic, and there are a large number of agents (drivers, firms, residents, and so on) being affected adversely. It is very difficult and costly to organize the victims to correct the externality themselves. In other words, no automatic, inexpensive correcting mechanism for traffic congestion exists. In many cases, some kind of government interventions may be less costly. The question is what kind of intervention is needed.

4.3 Externality and Government Intervention

Assuming that externality does exist, the next step is to find out the right government intervention. From the discussion in the previous subsection, we see the importance of examining the nature and causes of an externality issue. It is beyond this simple note to give an exhaustive analysis of all types of externality. In the trade literature, the most common policy intervention considered is the use of taxes/subsidies to direct the price taking agents in the economy to move the market equilibrium to a more desired (from the economy's point of view) point. Let us refer back to the sectoral production function given in (8).

As pointed out earlier, the problem of the externality can be explained in terms of the private marginal product of a factor given in (4) and its social marginal product given in (22). Since the firms pay the factors according to their private marginal products while the government wants the factors to be paid according to their social marginal products, the government can fill in the gap by using taxes/subsidies. Let the market price of factor j be w_j, which is the price paid by firms, i.e., cost-minimization implies

$$w_j = p_i \frac{\partial F_i}{\partial v_{ij}}, \tag{23}$$

where p_i is the market price of good i. Condition (22) implies that the government can impose a subsidy s_{ij} to factor j in sector i equal to

$$s_{ij} = p_i \phi_{ij}, \tag{24}$$

which is evaluated at the optimal point. If ϕ_{ij} is negative, a tax will be required. Multiply both sides of (22) by p_i, making use of (23) and (24), to give

$$p_i SMP_{ij} = w_j + s_{ij}, \tag{25}$$

which is what factor j in sector i receives. The subsidy is then needed to correct the externality effect.[8]

5 Concluding Remarks

This simple note gives a brief introduction to externality and the treatment of externality in the trade literature. Because of the space constraint, we are not able to give an extensive discussion of externality. In fact, the purpose of this note is not to discuss externality per se. Rather, it is to bring out and discuss the basic concepts and features of externality so that readers can find the accompanying papers easier to follow.

In the accompanying three papers, we will analyze more specifically some of the issues in the theory of international trade when externality is present. Wong (2000a) introduces the basic model, new techniques for analyzing models with externality, and examines the validity of five fundamental trade theorems. The basic model has the characteristics that one of the two sectors in an economy is subject to externality while the rest of the model is the same as a neoclassical framework. The basic model is thus very useful for examining the roles of externality because any new results obtained can be attributed to the presence of externality. The techniques introduced in the paper greatly simplifies the analysis, allowing us to obtain more results. The five fundamental trade theorems are derived in the neoclassical framework. It is therefore important to determine whether they are still valid in the presence of externality.

Wong (2000b) extends the basic model to allow the possibility of own-sector externality in both sectors and cross-sector externality. More results are derived, but in general they are weaker than those obtained in the basic model. The paper also examines the use of government tax/subsidy policies.

[8]For more discussion, see Wong (2000b).

Wong (2000c) extends the basic model in another direction: allowing both trade in goods and international capital movement between two countries. The model is used to analyze how international capital movement, which is growing fast in the world, may interact with trade in goods. A model that can be used to analyze such interactions is developed.

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