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"SHORT-TERM INFANT INDUSTRY PROTECTION"

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Abstract

A two-good model of a small open economy, in which production of one good is characterized by an extra-firm, intra-industry externality, is constructed. In contrast to previous studies of infant-industry protection, the planning horizon is considered to be finite. The conditions under which protection is justified are determined and the factors that influence the time path of the optimal subsidy are shown to be the length of the planning horizon, the scale of the externality, and the rate of time discounting applied.

1. Introduction

The standard neoclassical model of international trade provides no theoretical basis for arguing that a policy of free trade will maximize both its short-run income and its long-run income. Imposing a tariff on the goods that the country imports will encourage a flow of domestic factors into those industries. The country's short-run income is decreased, due to the inefficient factor allocation, without there being any offsetting long-run gain. Were the tariff to be later removed, the factor flow would be reversed and trade would resume according to the original pattern of comparative advantage.

What then is the impetus for protecting an industry? Somehow the imposition of distortionary taxes, while reducing income in the current period, must be perceived to yield longer term benefits through altering a country's comparative advantage in international trade. Thus, in some fashion, the experience a country gains from producing a good under the protection of a tariff wall must translate into greater productivity, such that the industry will be able to survive once the country returns to a policy of free trade.

Kemp (1960) suggested that protection could be justified in circumstances where the costs of producing a good decline, the greater the

quantity of the good that has been produced in the domestic market. Thus firms learn how to utilize capital and manage workers more effectively through their own experience and those of other firms in the economy. A firm which is an early entrant to the industry bears the current costs of production itself but reduces the future costs of production of all firms. One could think of such an early entrant as producing a joint product, say knowledge, with public good characteristics that it cannot effectively market. [On this, see Johnson (1970) and Markusen (1986)]. In this way the private benefits to the firm of its investment in acquiring technical knowledge are less than the social benefits to the country as a whole. The government, by subsidizing the initial production costs (or raising the price of output) may induce the firm to increase the early production of the good and thereby quickly establish the new pattern of comparative advantage.

The argument that is being made for infant-industry protection is thus quite distinct from the other, familiar justification based upon inefficient or non-existent capital markets in less developed countries--even in the presence of perfect capital markets a firm will choose to produce less than the socially optimal level of output because it cannot capture the returns to the externality.

Kemp examines the requirements for infant industry protection. He applies the so-called Mill-Bastable conditions to the case where the domestic industry catches up with foreign producers. Assuming that the learning process does not allow pioneer firms to appropriate the advantages of early entry, protection is justified only if the industry can survive on its own merits once the protection is removed (the Mill test) and if the later savings compensate the community for the learning costs (the Bastable test). Bardhan (1970 and 1971) looks also at the case where the learning process is

continuous, in that the benefits from protection persist indefinitely. In the infinite-time-horizon case that he examines, the optimal subsidy converges to a steady-state level that should be maintained in perpetuity.

The contribution of this paper is in considering infant-industry protection within a finite planning horizon. The justification for this "myopia" may rest on, for example, the electoral process within the country, whereby the benefits of any scheme must be realised within certain time limits to ensure the re-election of the government. Under these conditions, it is shown that the optimal subsidy declines to zero in the last period even with continuous learning.

In the following section, a formal model justifying infant-industry protection on the basis of "learning-by-doing" endogenous technology is laid out. The time path over the planning period of the optimal subsidy is then determined and is compared with that for the case of an infinite time horizon. The paper concludes with a summary.

2. The Model¹

Consider a small, open economy populated by identical agents² in a world in which two goods, X and Y, are produced and traded at a fixed international relative price of p (the price of good Y expressed in units of good X). The country is also small relative to international financial markets such that it can borrow (or lend) at the existing rate of interest, R . Both goods are produced using inputs of the two factors, K and L, which are in fixed supply over time³, according to neoclassical production functions exhibiting constant returns to scale. The efficiency with which good X is produced depends on the prior experience in the economy at producing the good--the more that has been manufactured in the past, the more that can

be manufactured with any combination of capital and labour inputs. Thus moving along the "learning curve" takes the form of Hicks-neutral technical progress. The technology used in the production of Y is assumed to be independent of the level of prior production activity. Considering discrete time periods:

$$X = \sum_{t=0}^{t-1} g(\bar{X}) F(K_{xt}, L_{xt}) \quad (1)$$

$$Y = G(K_{yt}, L_{yt}) \quad (2)$$

$$\bar{L} = L_{xt} + L_{yt} \quad (3)$$

$$\bar{K} = K_{xt} + K_{yt} \quad (4)$$

where the learning technology may be characterized as:

$$g[0] = 1, \quad g' > 0, \quad g'' \leq 0. \quad (5)$$

either education always enhances productivity, the public goods aspect of X production never diminishing, or it involves initially rapid adaptation which then declines in pace as more experience of X-production is gained and the developing country "catches up". In the former case the second derivative equals zero and the marginal productivity of learning is a constant. The latter case has the second derivative being strictly negative.

Suppose that, up to the present period ($t=0$), the government of the country has pursued a policy of free trade and that the country is relatively heavily endowed with labour, such that the overall capital-labour ratio lies outwith those necessary for non-specialization in production at the prevailing international price ratio. Figures 1 and 2 illustrate this equilibrium in the Lerner diagram and the diagram of the transformation function, respectively.

The atomistic firm, in the absence of government policy, may choose to specialize in the production of Y--because the costs of producing contrary to

comparative advantage are too great relative to any future reduction in the costs of producing X. Should it choose to produce any X, its immediate revenues will decline. The X production lowers the future cost of further X production but this lower-cost technology is available to all producers. Thus the benefits to the country as a whole exceed those which are garnered by the firm which incurred the initial costs. Because that firm equates marginal private costs to marginal private benefits (which are less than social marginal benefits) the initial quantity of X production will be less than the socially optimal amount, if indeed there is any at all. It is this externality which provides grounds for government policy.

3. Government Policy

What then is the optimal government policy? Let the government seek to maximize the present value of its production over a planning horizon extending T periods into the future. Future income is discounted at a rate d where $d < 1$ (the greater is d, the less is the future discounted). If the country is able to borrow on an international financial market at interest rate R, then

$$d = \frac{1}{1 + R} \quad (6)$$

The greater the cost of borrowing to finance current consumption, the less valuable is future income. With given R and p, this government strategy would permit the maximum level of welfare to be achieved, irrespective of the country's social welfare function. Accordingly, the government maximizes the present value of national income N, where

$$N = \sum_{t=0}^T I_t d^t \quad (7)$$

and I_t is the value of output in period t measured at international prices.

$$Y_t = X_t + p Y_t \quad (8)$$

Differentiating with respect to K_{xt} and L_{xt} , and solving provides first-order conditions of the form:

$$S_t \sum_{i=0}^{t-1} g_i [X] F [K_{xt}, L_{xt}] = p G [K_{yt}, L_{yt}] \quad (9)$$

$$S_t \sum_{i=0}^{t-1} g_i [X] F [K_{xt}, L_{xt}] = p G [K_{yt}, L_{yt}]$$

where:

$$S_t = \sum_{i=0}^{t-1} g_i J_i \quad (10)$$

and⁴

$$J_0 = 1$$

$$J_1 = g'_1 F_{t+1} \quad (11)$$

$$J_i = g'_i F_{t+i-1} \prod_{j=1}^{i-1} (1 + g'_j F_{t+j-1})^{-1}, \text{ for } i > 1$$

It may be determined from (10) and (11) that, as the J 's are always positive, the S_t terms are always greater than unity. This is because a unit of labour or of capital that is used in X production in one period also increases the productivity of inputs into X production in all future periods, as can be seen in the product term of equation (11).

Without intervention, the free market would result in labour and capital being allocated between sectors in each period such that their respective marginal productivities were equalized:

$$r = \sum_{i=0}^{t-1} g_i [X] F [K_{xt}, L_{xt}] = p G [K_{yt}, L_{yt}] \quad (12)$$

$$w = \sum_{i=0}^{t-1} g_i [X] F [K_{xt}, L_{xt}] = p G [K_{yt}, L_{yt}]$$

Comparing the expressions in (9) to those in (12), it can be deduced that the solution to the dynamic planning problem must involve more labour and

capital being allocated to the X-sector than would otherwise occur without government intervention. Thus the "dynamic" marginal productivities of factors used to produce X exceed their "static" marginal productivities. Note that the distortions in the labour market and the capital market are the same, in the sense that the ratios of marginal productivities of labour relative to capital are the same in both X and Y production (because of the assumption of Hicks-neutral technical progress). The policymaker's task is therefore to affect the relative price facing producers in the economy such that they become inclined to produce the socially optimal quantity of X. This requires an increase in the relative price of X in each period in the domestic economy, such that:

$$p_t^d = p / S_t \quad (13)$$

It is clear that the rate of the subsidy that should be given to producers of X in each period is therefore⁵:

$$s_t = S_t - 1 \quad (14)$$

Given that S_t is not constant over the planning horizon (irrespective of whether or not g' is a constant, what then is the time-path of the optimal subsidy and hence that of the domestic relative price?

In the terminal period of the planner, when $t = T$, then $s_T = 0$ and factors are allocated according to static optimality conditions--there is no justification for distorting current production because there is no interest in any future productivity gains. For $t = T-1$, the penultimate planning period:

$$s_{T-1} = d g'_{T-1} F_T > 0 \quad (15)$$

The allocation of factors in period T-1 increases the productivity of factors

in the final period as well. For each preceding period the s_t term increases, such that it is largest in the first period and declines steadily to the end of the planning horizon. The earlier that factors are reallocated to X production, the more periods will the benefits of increased productivity be received. Thus the domestic price distortion should diminish to zero over time. This result is independent of whether g' is constant or declining and is a consequence only of there being a fixed time horizon. In contrast, Bardhan (1970 and 1971) found that, with constant g' and an infinite time horizon, the subsidy would converge to a fixed, positive rate.

Were g' declining⁶, then the benefits from protection of the infant industry would further be diminished over time. This case would be similar both to that considered by Kemp (1960 and 1964) and to Bardhan's "temporary learning", as the developing country's industry catches up with the technology enjoyed by its competitors. In the infinite horizon case the optimal subsidy declines until there is no further learning ($g' = 0$). In the situation considered here, where the planner faces a fixed time horizon, both the length of the horizon and the decline in learning cause the optimal subsidy to diminish. The subsidy will certainly fall to zero by time T and may disappear before that if the technology "catch-up" is sufficiently rapid.

These results are illustrated in Figure 3, which maps out the time paths of the optimal subsidy under the different assumptions as to technology and time horizons⁷. For g' constant and an infinite time horizon, s_B converges to a positive rate s^* . For time horizon T, the comparable path of a subsidy is s . Were learning only temporary (g' declining), s_K or s_C could be the path for an infinite time horizon, while either s or s_C could correspond for the finite time horizon.

Kemp (1960) proposed the "Mill-Bastable dogma" whereby an industry should be protected if it passes both the "Mill test" and the "Bastable

test". The "Mill test" is satisfied if the industry's technology has improved sufficiently that it will continue to produce its product efficiently, once the protection is removed. Thus the "Mill test" is met in this case if the capital-labour endowment of the economy ends up lying in the cone of diversification at the prevailing international price ratio. The "Bastable test" requires the gains from this protection to outweigh the short-run costs of the production distortion that is generated. Thus, in each period, the present value of the increase in future income over the time horizon must be measured against the current cost of the protection.

4. An Example: the Two-period Case

As an illustration of the use of this analysis, consider a horizon extending from the current period to the next period, that is $T=1$. What then is the optimal policy? Solving equation (10) for the periods $t=0$ and $t=1$:

$$s_0 = S_0 - 1 = d g' [x_0] F[K_{x1}, L_{x1}]$$

$$s_1 = S_1 - 1 = 0$$

Thus in the initial period there should be a subsidy to the production of X such that the domestic relative price of X is distorted from the international terms of trade:

$$p^d = \frac{p}{1 + s_0}$$

The size of the subsidy depends on the rate of discount, d , and the rate at which technology to produce X advances as a result of production of the good, $g' [x_0]$. The greater the technological improvement resulting from a certain amount of production and the less the value of future income is discounted (the larger is d), the more worthwhile the current investment in X production and hence the greater the optimal subsidy.

This result is illustrated in Figure 4. The production subsidy reduces the value (at international prices) of domestic production from I_0 to I_0' . This is offset in the following period by the increased value of output I_1 encouraged by the subsidy. Had there been no subsidy, the value of output would have remained at I_0 . Thus the future increase in income is $(I_1 - I_0)$. The policy intervention is therefore worthwhile if the initial cost is less than the present value of the future income increase, i.e., if $(d(I_1 - I_0))$ is greater than $(I_0 - I_0')$. A tariff, in contrast to a subsidy, would also introduce a distortion into the consumption decision. This would further reduce welfare in the initial period.

The influence of the presence of an international financial market is illustrated in Figure 5. That output, and hence national income, can be increased in the second period at the cost of reduced income in the initial period is represented by the transformation curve TT' , with income in the absence of government policy being the same in both periods, at point T. The intertemporal consumption bundle can be any point along a budget line AA' with slope d passing through T. Government intervention in the form of the production subsidy shifts the intertemporal income bundle to point B, where the domestic rate of intertemporal income transformation (the slope of TT') equals the international discount rate d . Consumption can then take place on a higher budget line CC' than was possible without the policy.

5. Conclusion

This paper has presented a simple, formal argument for a policy of protecting infant industries in the presence of economies external to the individual firms. The planner has, in contrast to previous analyses, been

considered to have a finite time horizon. Such an assumption conforms to the institutional constraints faced by many countries and is shown to create a significant change in the path of the subsidy chosen to protect the infant industry, in that the subsidy will diminish to zero by the end of the planning period.

It should be pointed out that this justification for infant industries is, in some senses, fairly general. For example, there is no requirement that the chosen industry export the product after all adjustments have taken place; there is even no need for imports of the chosen product to stop once the industry is established. All that is required is that some production of the Product be efficient once the economy returns to the undistorted state (i.e. that continued distortion is not necessary for the industry's survival) and that the long-term gains, suitably discounted, offset the short-term costs. It is clear that the policy prescription applies, not only to less-developed countries, but also to developed economies.

Footnotes

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¹ Apart from the obvious differences between the time horizons considered, the model is essentially the same as that used by Bardhan (1970 and 1971).

² All this assumption does is rule out the necessity for government income redistribution policies.

³ Population growth and capital accumulation are not considered in this paper.

⁴ The P_t term is the abbreviated expression for the production function in period t .

⁵ This is often considered to be the salient feature of infant industries.

⁶ Also clear is that a tariff would be a second-best policy in that it introduces a distortion into the consumption market which previously was efficient.

⁷ The initial levels of all the subsidies are drawn as being the same, though this is not, in general, the case.

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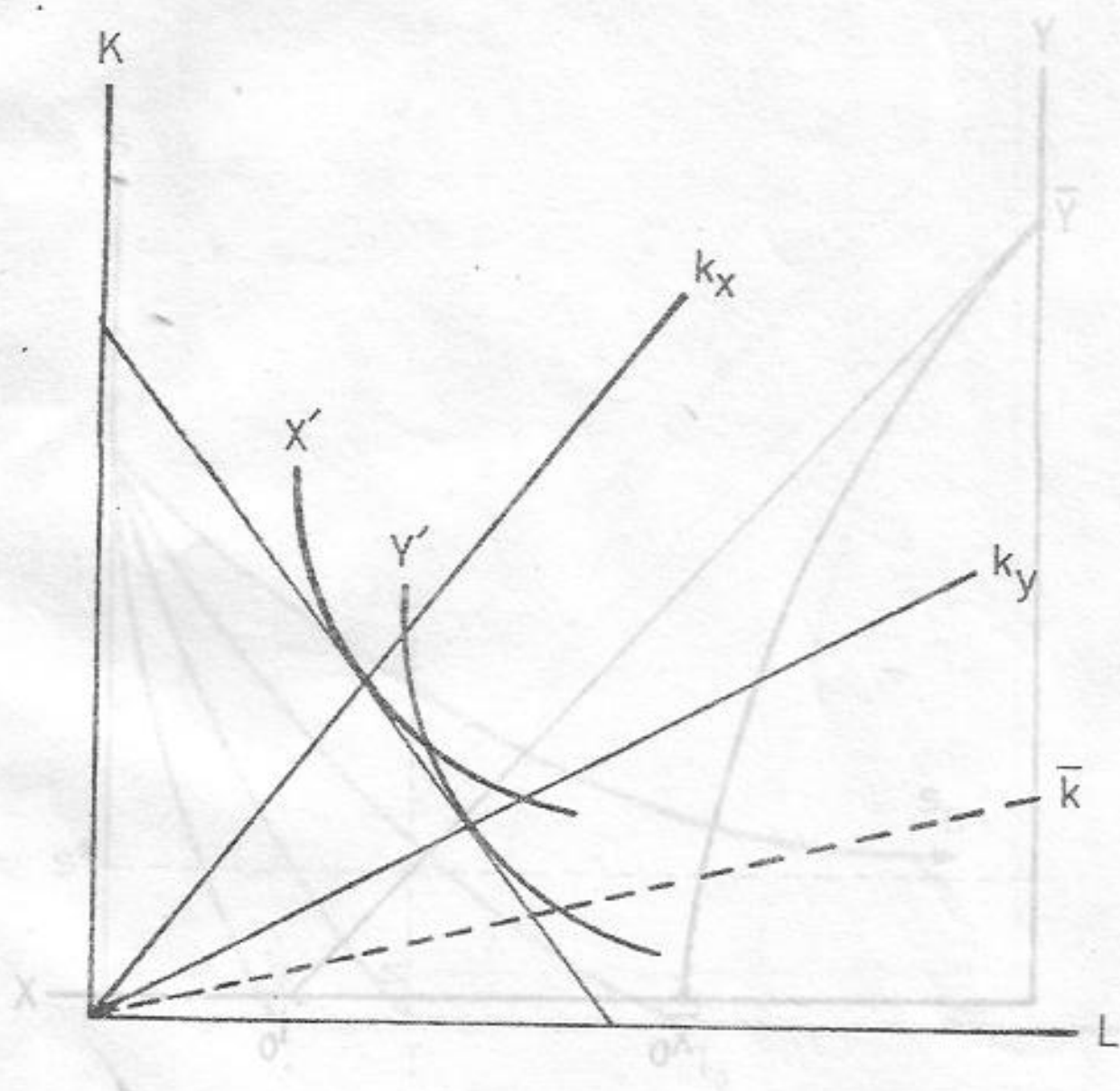


FIGURE 1

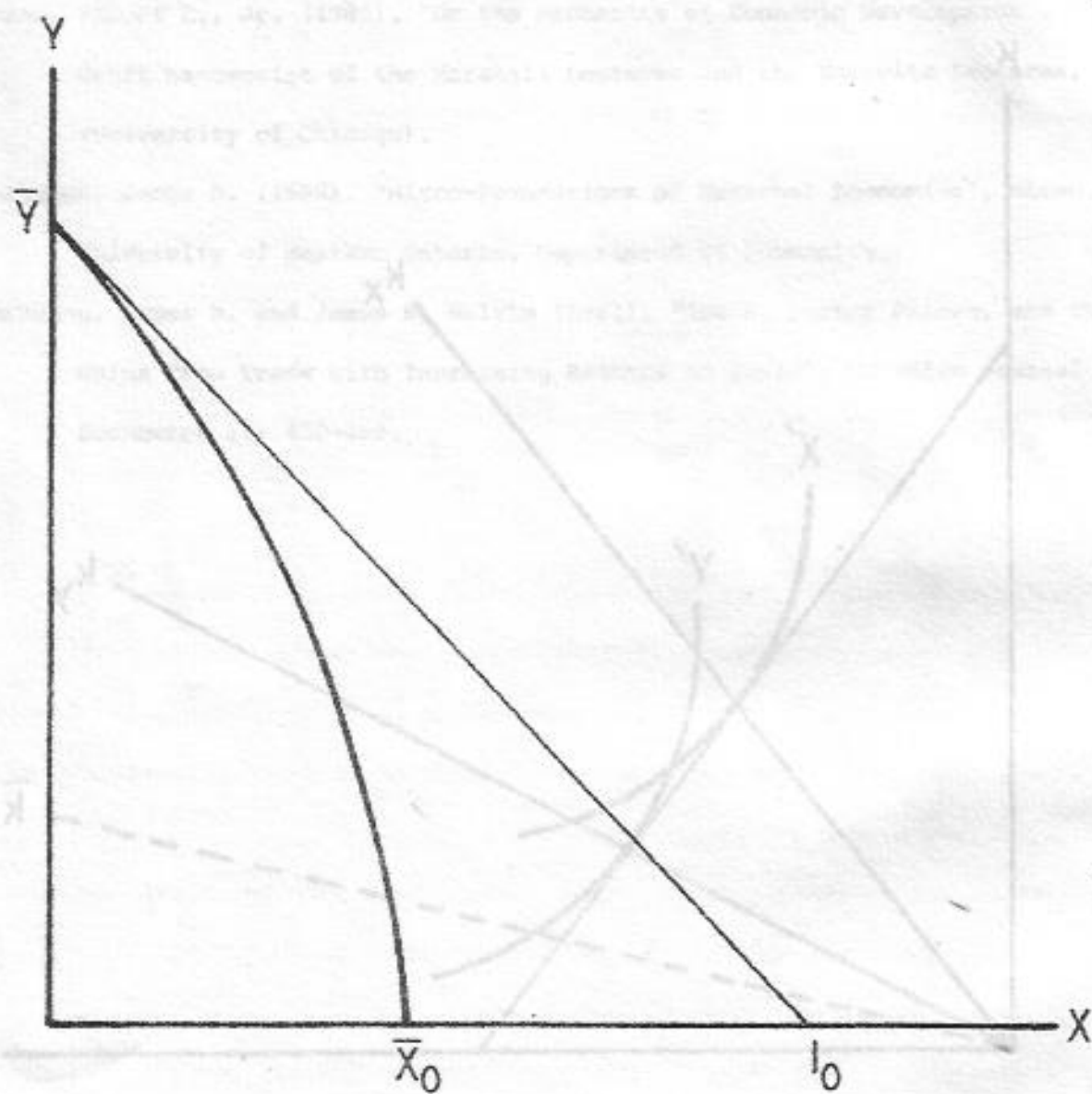


FIGURE 2

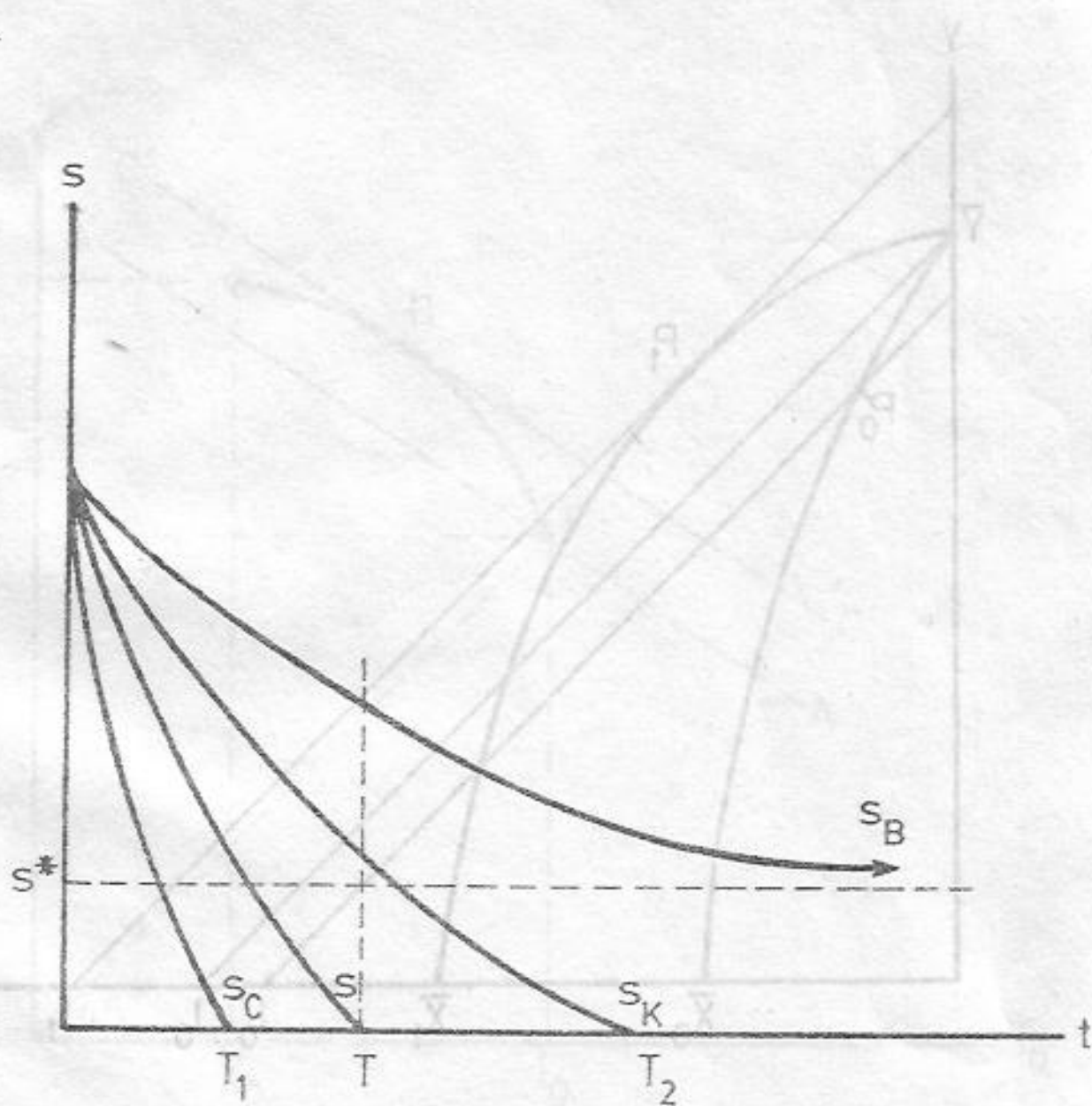


FIGURE 3

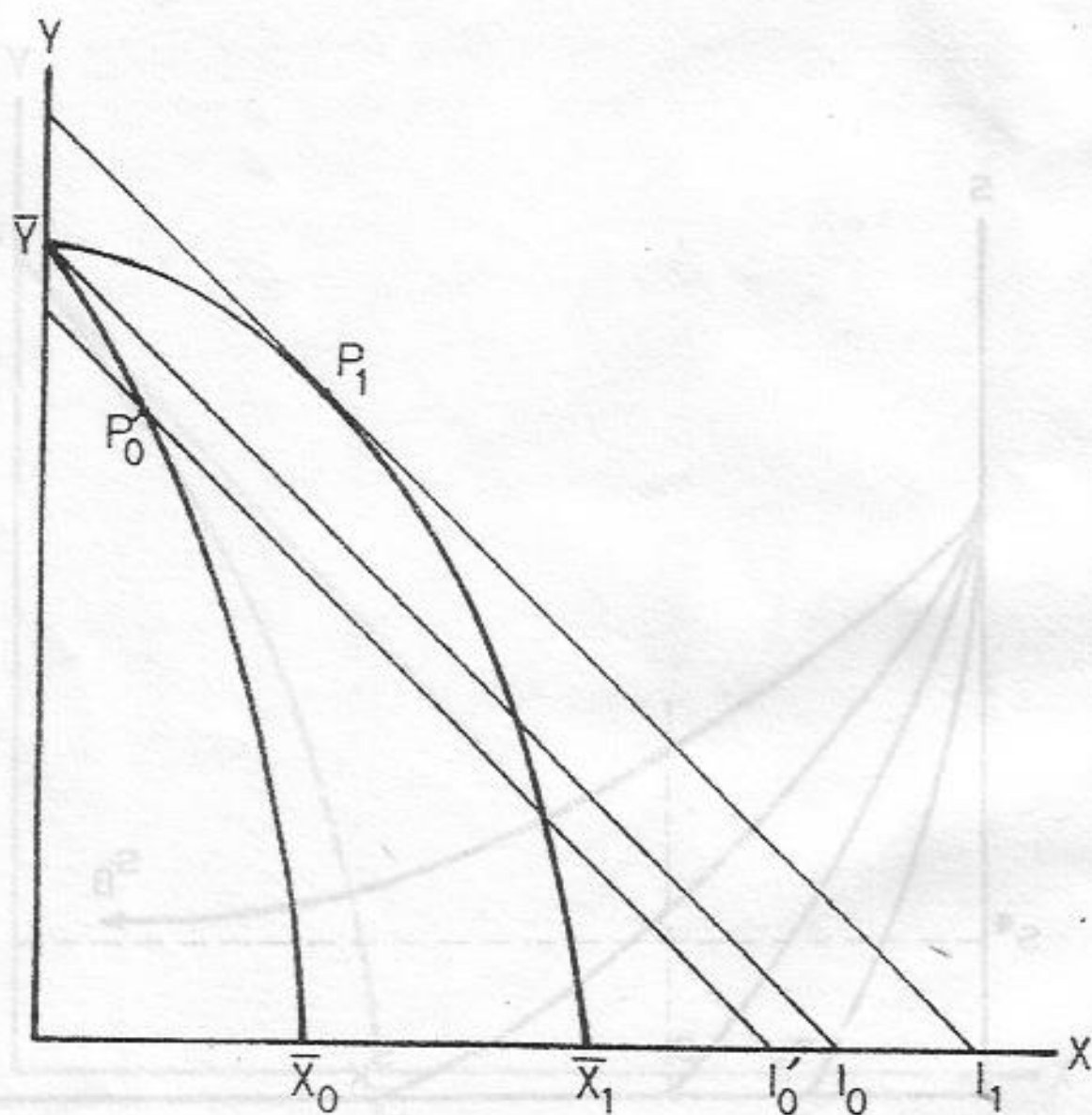


FIGURE 4

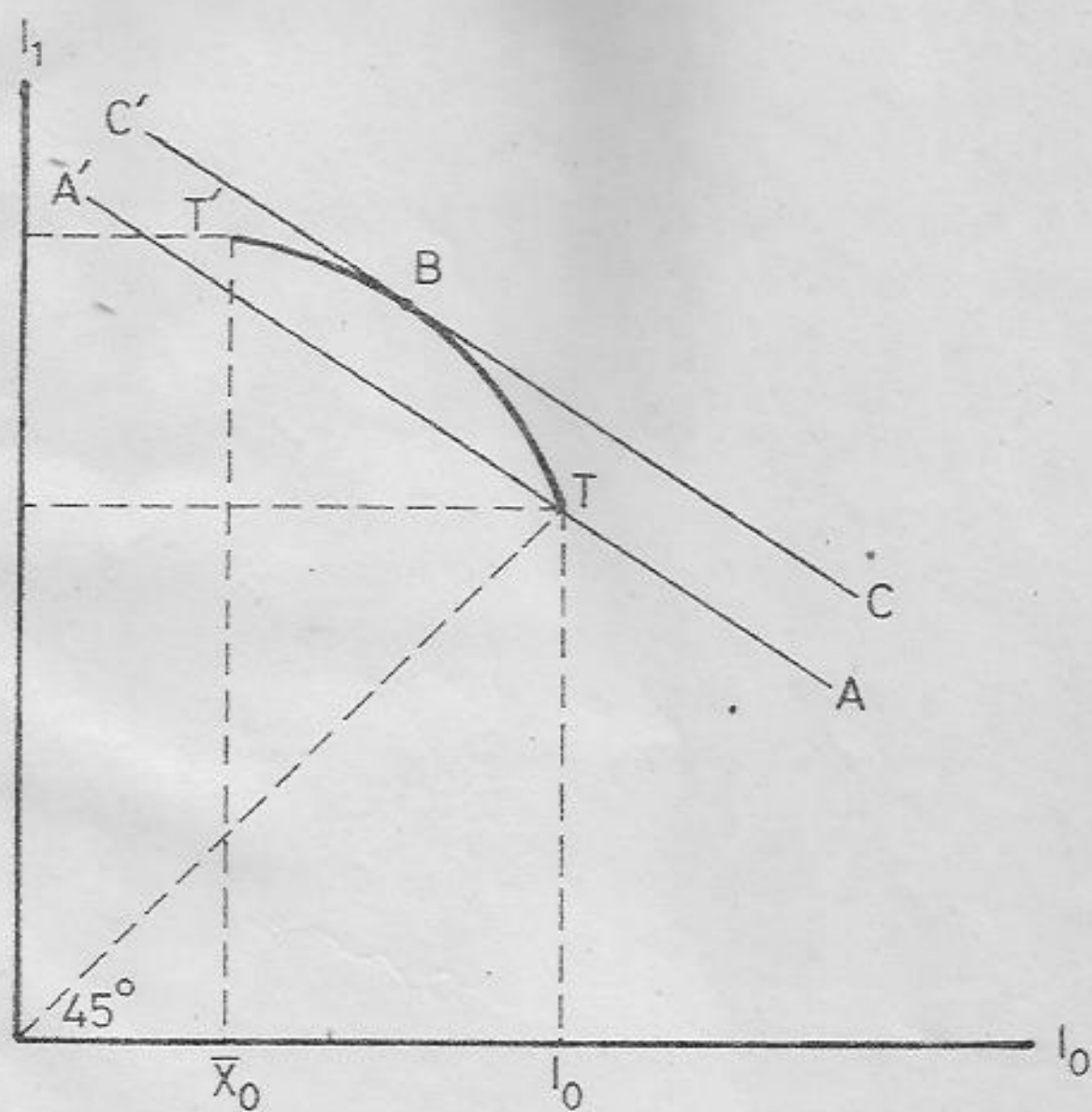


FIGURE 5