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A Positive View of Infant Industries

Cayetano Paderanga

Ian Wooton

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Cayetano Paderanga Jr.

and

Ian Wooton

This paper contains preliminary findings from research work still in progress and should not be quoted without prior approval of the author.

DEPARTMENT OF ECONOMICS
THE UNIVERSITY OF WESTERN ONTARIO
LONDON, CANADA
N6A 5C2

"A Positive View of Infant Industries"

by

Cayetano Paderanga Jr.
The University of Western Ontario and The University of the Philippines

and

Ian Wooton
The University of Western Ontario

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1. Introduction

The standard neoclassical model of international trade provides no theoretical support for the protection of an infant industry. In such a model, technology is unchanging and shared by all countries while factors are perfectly mobile between industries within each country's frontiers. Thus, in every period, factors are effficiently allocated. A small country, with no monopoly power in trade, by pursuing 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. Following a suggestion of Lucas (1985), suppose that 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 Markusen (1984)]. In this way the private costs to the firm exceed the social costs to the country as a whole. The argument that is being made for infant-industry protection is thus quite distinct from the 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. 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 approach adopted is thus the same as that of Kemp (1960 and 1964) in which the learning process is external to the firm yet internal to the industry. The contribution of this paper is in providing a simple theoretical model and determining explicitly the optimal policy strategy, including the conditions under which infant-industry protection is justified.

2. The Model

Consider a small, open economy populated by identical agents[1] 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 time[2], 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 production activity. Considering discrete time periods:

$$X_t = g[\sum_{t=0}^{t-1} X_i] \, F[K_{xt}, L_{xt}] \qquad (1)$$

$$Y_t = G[K_{yt}, L_{yt}] \qquad (2)$$

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

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

where the learning technology is such that adaptation is initially rapid, but then declines in pace as more experience of X-production is gained:

$$g[0] = 1$$
$$g' > 0 \qquad (5)$$
$$g'' < 0$$

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 outside the cone of diversification 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. This involves discounting future earnings at a rate d, where

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

The larger is d (the smaller is R), the less future incomes are discounted. With given R and p, this policy permits the maximum level of welfare to be achieved, irrespective of the country's social welfare function. The government then maximizes the present value of national income N, where

$$N = \sum_{t=0}^{T} I_t d^t \tag{7}$$

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

$$I_t = X_t + p Y_t \tag{8}$$

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

$$S_t g[\sum_{i=0}^{t-1} X_i] F_K[K_{xt}, L_{yt}] = p G_K[K_{yt}, L_{yt}]$$

$$S_t g[\sum_{i=0}^{t-1} X_i] F_L[K_{xt}, L_{yt}] = p G_L[K_{yt}, L_{yt}] \tag{9}$$

for t = 0,1,...,T

where:

$$S_t = \sum_{i=0}^{T-t} d^i J_i \tag{10}$$

and[3]

$$J_0 = 1$$

$$J_1 = g'_t F_{t+1} \tag{11}$$

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

The marginal products of capital and labour in any one period are, respectively,

$$r = g[\sum_{i=0}^{t-1} X_i] F_K[K_{xt},L_{xt}] = p G_K[K_{yt},L_{yt}]$$

$$w = g[\sum_{i=0}^{t-1} X_i] F_L[K_{xt},L_{xt}] = p G_L[K_{yt},L_{yt}] \qquad (12)$$

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). Thus the "dynamic" marginal productivities of factors used to produce X exceed their "static" marginal productivities. 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.

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 the of the assumption of Hicks-neutral technical progress).[4] 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 in each period in the domestic economy, such that:

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

Given that S_t is not constant over the planning horizon, what then is the time-path of the domestic relative price?

When $t = T$, that is that it is the terminal period of the planner, $S_T = 1$, and factors are allocated according to static optimality conditions--because there is no interest in the impact on future periods of current production. For $t = T-1$, the penultimate planning period:

$$S_t = 1 + dg'_{T-1} F_T > 1 \tag{14}$$

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, because, the earlier that factors are reallocated to X production, the more periods will the benefits be received. Thus the domestic price distortion should diminish over time. This result is in concordance with the received wisdom that an infant industry should only be protected until such time that it has learned to compete with the rest-of-the-world's production. Note that, as T (the length of the planning horizon) increases, the quantity of X production undertaken over time also increases and the g' term diminishes. Consequently, over an infinite time horizon, the domestic price will asymptotically converge to the international terms of trade.

It is clear that the tax-cum-subsidy that should be placed on production in each period is:

$$t_t = S_t - 1 \tag{15}$$

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.

Kemp (1960) proposed the "Mill-Bastable dogma" that 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 outweigh its short-run costs. Thus the present value of the increased future income over the time horizon, discounted at rate d, must be measured against the present value of the costs of protection.

In the next section the conditions necessary to satisfy the "Mill-Bastable dogma" are derived for a specific example.

4. An Example: the Two-period Case

Suppose that the policymaker has 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:

$$t_0 = S_0 - 1 = dg'[X_0]F[K_{x1}, L_{x1}]$$

$$t_1 = S_1 - 1 = 0$$

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:

$$p^d = \frac{p}{1 + t_0}$$

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 3. The production tax-cum-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 the same. Thus the future increase in income is $(I_1 - I_0)$. The policy intervention is therefore worthwhile in that it satisfies both the "Mill test" and the "Bastable test" 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 $(I_0 - I_0')$. Note that a tariff, instead of a tax-cum-subsidy, introduces an additional 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 4. 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 income from one period into the next at 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. It has been shown that the optimal production tax-cum-subsidy should diminish over time, as the rate of technological progress declines. Tariffs are second-best policies, as they distort consumption-choice,and may involve a reduction in welfare compared to a laissez faire policy.

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

[2] Population growth and capital accumulation are not considered in this paper.

[3] The F_t term is the abreviated expression for the production function in period t.

[4] The case of Harrod-neutral technical progress (where, say, labour alone learns) is considered in Paderanga and Wooton (1985).

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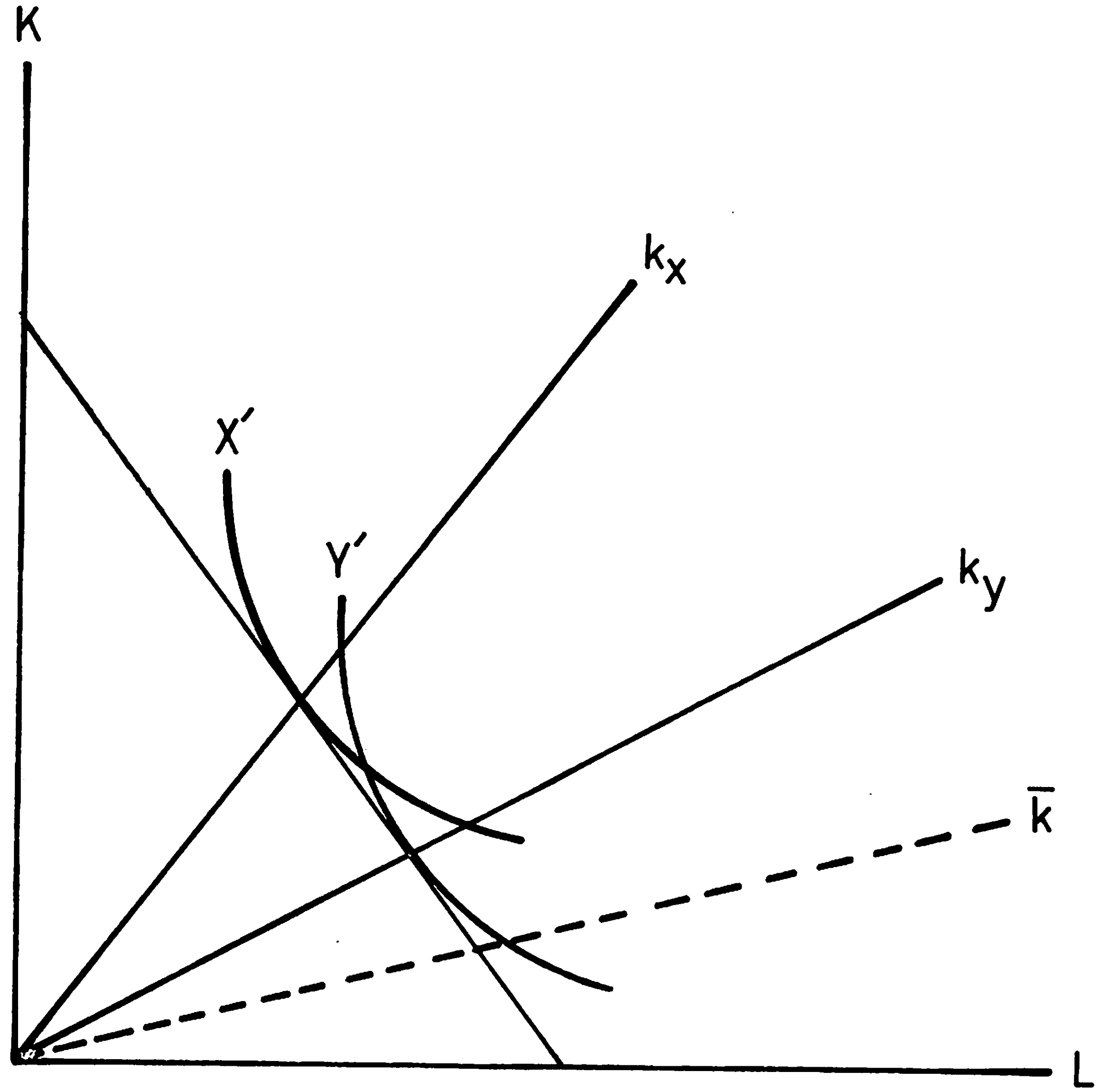

Figure 1

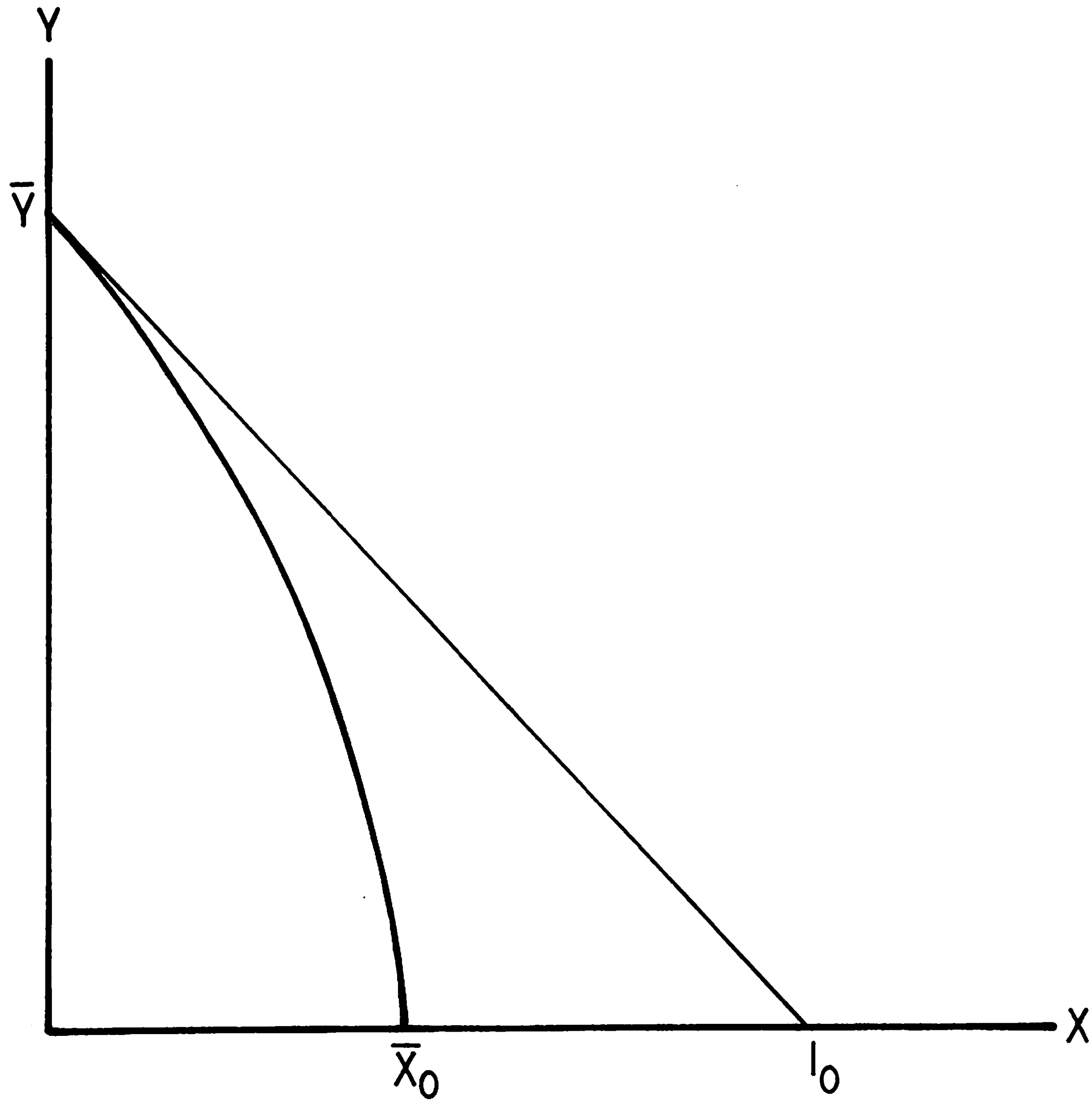

Figure 2

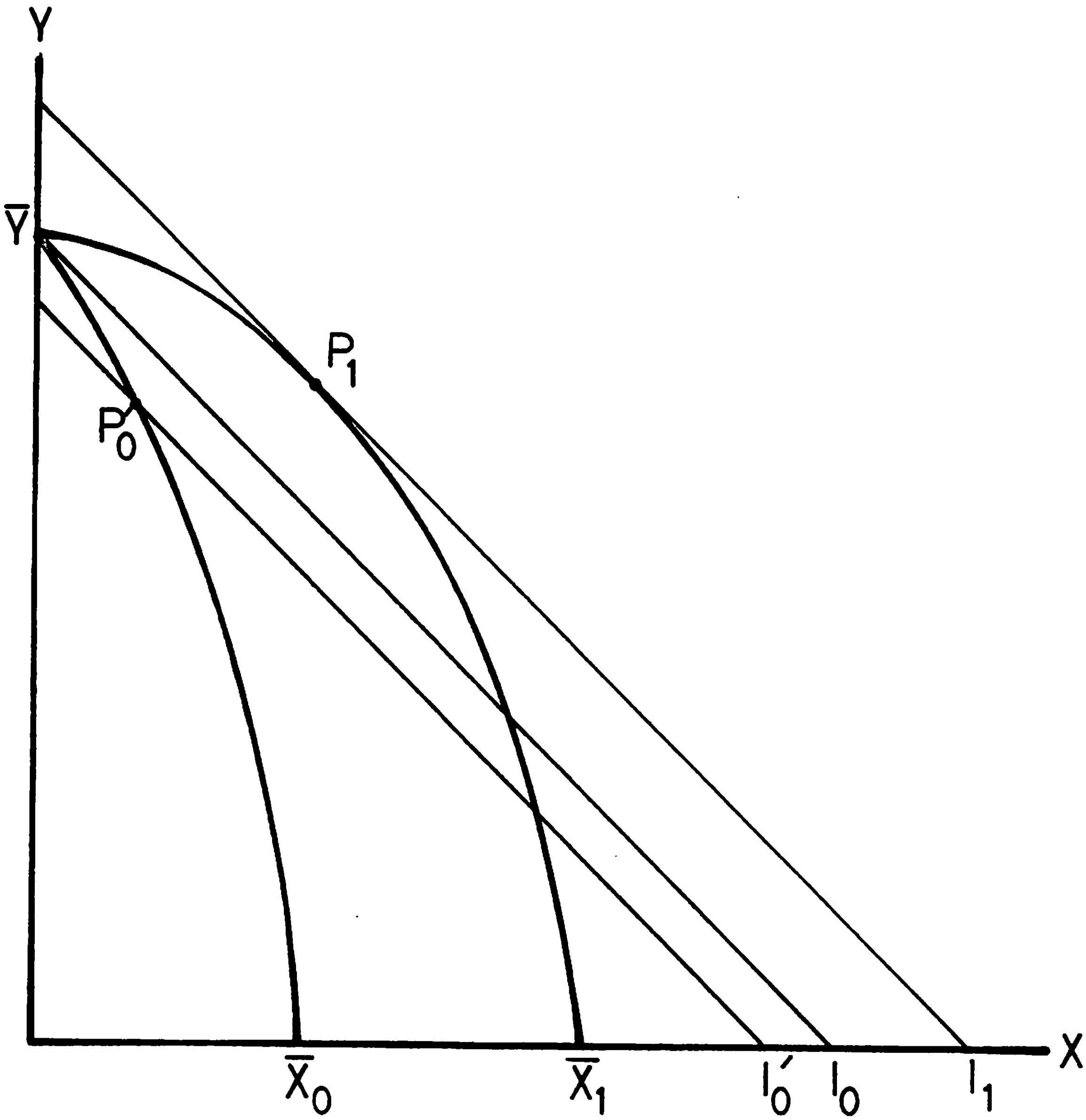

Figure 3

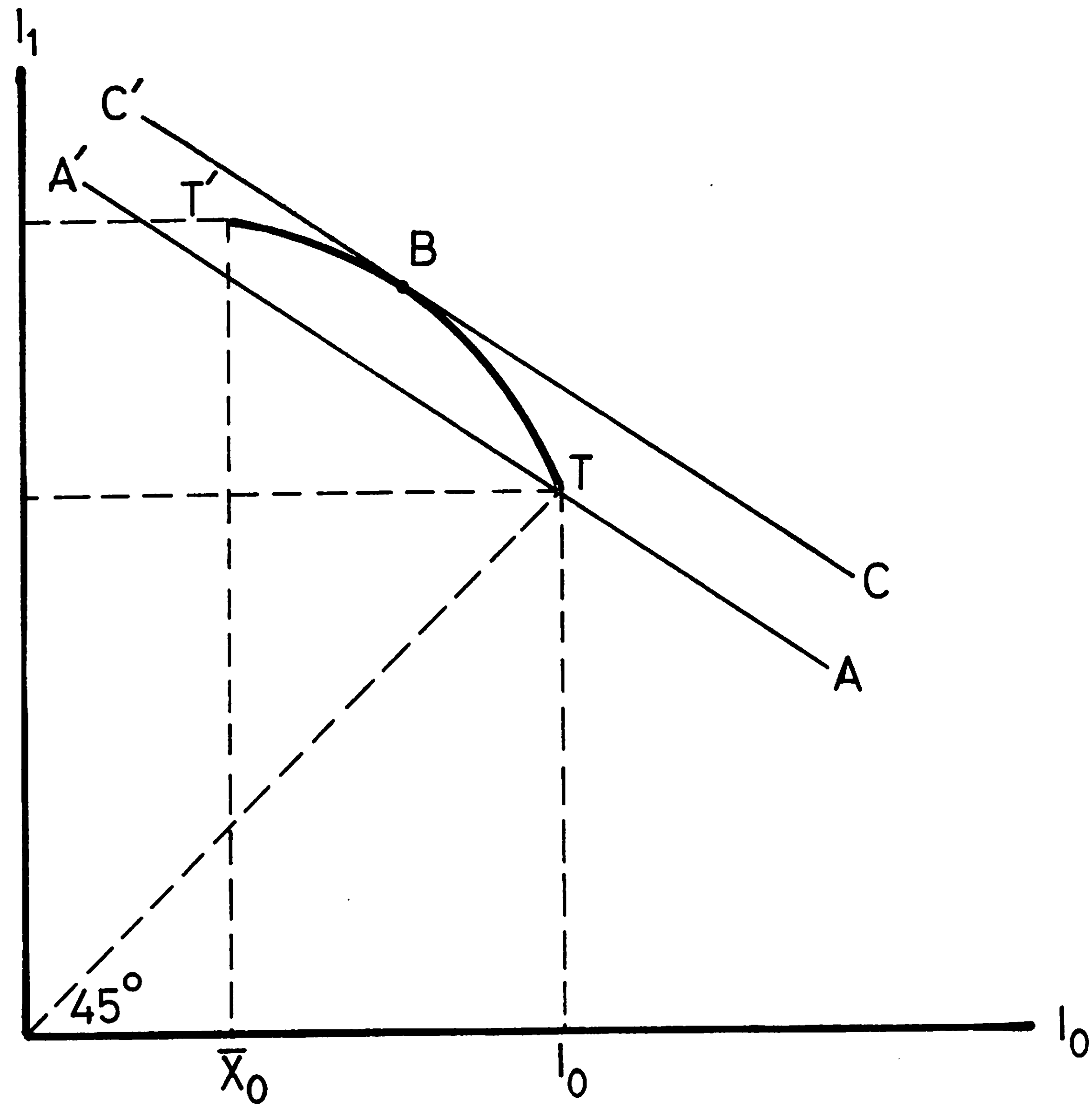

Figure 4

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