Optimal Subsidization and Structural Change under Monopolistic Competition with Technical Progress a la Ethier

Ziesemer, Thomas

U Maastricht, MERIT

1990

Optimal Subsidization and Structural Change under Monopolistic Competition with Technical Progress à la Ethier

Thomas Ziesemer

90-023

Maastricht Economic Research Institute on Innovation and Technology (MERIT)
Limburg University Maastricht, The Netherlands

MERIT, P.O. Box 616, 6200 MD Maastricht (Netherlands) - telephone (31)43-888742- fax: (31)43-216518

Optimal Subsidization, Growth and Structural Change in a North–South Model with Technical Progress à la Ethier*

THOMAS ZIESEMER University of Limburg, Faculty of Economics and Maastricht Economic Research Institute of Innovation and Technology (MERIT), The Netherlands

Abstract. The North produces differentiated intermediate factors in monopolistically competitive firms. North and South produce consumption goods using the finite number of factors. The world optimum can be reached through a combination of ad valorem and specific subsidies, which converges to a simple rule of thumb for large numbers of firms. A widening of the market leads to a higher number of firms, a higher ad valorem subsidy and a lower specific subsidy and has no impact on the optimal size of the firm. If population growth in the South is higher than in the North, a higher share of intermediates will be exported from North to South, production of consumption goods will grow faster in the South than in the North and employment in the North will shift to the monopolistic sector. If the North pays the subsidies alone there is a redistribution from North to South which may make subsidies a subject in international negotiations.

*I would like to thank Theon van Dijk, Michael Kohlhaas, Rob Maesen, Ulrich K. Schittko, Johannes Schneider and Christine Süß for helpful comments without implicating them in any opinions expressed in the paper. JEL–Class.: 110, 410, 621. Keywords: growth, structural change, technology.

1. Introduction

There is a strong view now that the best rule of thumb for national trade policy is free trade (see Helpman/Krugman, 1989). The argument is that there is a large variety of imperfect competition models yielding different x–best trade policies and the government cannot know which model is the correct one. Modern trade policy has been developed from the point of view of national welfare.

However, if one holds the view that national welfare in the present real world of international institutions like the GATT can only be maximized within a framework that cares for world welfare, conditions for a world optimum become relevant. From the point of view of world welfare the wide spread notion in the literature, that a world optimum requires prices which equal marginal costs becomes relevant. This is the only robust result from all increasing returns models. This is not necessarily meant to say that international institutions should try to implement this optimum, but it may serve as a good benchmark for policy purposes.

The purpose of this paper is to provide a model that considers such an optimal policy. The following basic assumptions are made to capture the most interesting features for such model:

a) Differentiated products can be held to be the more general case if compared to homogeneous products. This is viewed here as being the most interesting case under certainty (for an interesting case under uncertainty see Grossman/Helpman, 1989c).

b) In a general equilibrium model with market access zero profits are likely to occur approximately, except for markets with very small numbers of firms which had been the subject of strategic trade policy.

c) If the zero profit condition is accompanied by the equality of prices and marginal costs, a policy variable must cover fixed costs. Thus, this must be some form of subsidization.

With the exception of Markusen (1988), who treats subsidies in a migration context there exists no analysis which considers this case of free trade under optimal subsidies. In the North–South context of this paper migration is not allowed to exist.

Of course the imposition of an exactly optimal subsidy may be a difficult practical task. However, this assumption is not more unrealistic than the assumption of "small dose" tariffs or taxes usually investigated in the literature [see Flam/Helpman (1987) and Helpman/Krugman (1989)] although realistic values might be far from "small doses".

As the aim of policy analysis under certainty is to derive rules of thumb, it may be considered an interesting question, in which way optimal subsidies, firm size and the number of firms and the structure of production, trade and employment behave in a growth context.

This paper provides a North–South model to analyse this question. The comparative static method of growth is used to investigate the effects of a widening of the world market through population growth.

The more detailed structure of the model is determined by the following further assumptions:

d) There is a differentiated factor and an outside factor both used to produce a consumption good in both countries. The South is defined to be unable to produce the differentiated intermediates for exogenous reasons, thus North–South trade is inter–industrial which is in closed accordance with the stylized facts [see Markusen (1986)]. Moreover, the South is less productive in the production of the consumption goods. A larger variety of differentiated factors is assumed to produce technical progress à la Ethier (1982).

e) The number of varieties, each produced by one firm, may be small or large. In the literature this posed some problems to solve the models because the formula for the price elasticity contained the number of firms. The first "way out" of this problem was to simply drop the elasticity term that contained the number of firms [see among others Dixit (1984), Flam/Helpman (1987)]. In more recent papers there is a second "way out". Grossman/Helpman (1989a, b, c and 1990a) use the assumption of a continuum of varieties thus distinguishing between the infinitely large number of firms and the measure of the integral of the continuum. In this paper we don't restrict the number of firms. The problem of solving the model is avoided because in an optimal model a solution can easily be derived as prices become equal to marginal costs and subsidy payments equal to fixed costs.

To keep the model as simple as possible, absence of any costs of producing blue prints before going to produce the differentiated varieties is assumed.[1]

The results obtained with this model are as follows.

(i) Growth of all central variables except for the quantity of a variety depends on the number of varieties.

(ii) The optimum can be brought about by some combination of ad valorem and specific subsidies.

(iii) If population of whichever country grows, the outcome is a larger number but constant size of firms and the optimal ad valorem subsidy increases, whereas the optimal specific subsidy decreases.

(iv) If population growth in the South is higher than in the North, a larger share of all intermediates will be exported from North to South; employment of the North will be shifted to the monopolistic sector and supply of consumption goods will grow faster in the South.

(v) Whether or not it pays for the North to finance the subsidies alone depends on the relative size of the countries. If the North is sufficiently large (small) it will (not) pay to finance the subsidy alone. The possibly redistributive effects of financing the subsidies pose a task for international negotiations in this model.

The paper is organized as follows. In section 2 the model is presented. Section 3 contains the optimum version of the model and its solution in growth rates. In section 4 the dependence of the number of firms on the size of the market is shown and the results for structural change in trade, employment and production are derived. Section 5 compares market equilibrium and optimum and shows that optimality may be derived under some combination of ad valorem and specific subsidies. Section 6 discusses result (v), some rule of thumb policy, fixed cost covered through subsidies and gains from trade. Section 7 contains some considerations concerning the implementation of such subsidies.

2. The Model

Consumption goods in country i are assumed to be produced through n differentiated intermediates x^j, labor L^{ic}, where c indicates "competitive sector", under Harrod neutral technological parameters A^i by the following production function

$$Y^i = [\Sigma_{j=1}^{n}(x^{ij})^{\delta}]^{\gamma/\delta}[A^iL^{ic}]^{1-\gamma} \quad i = 1, 2; \; \delta, \gamma < 1 \tag{1}$$

Country 1 is called South and country 2 is called North. Setting $A^2 \equiv 1$, $A^1 \leq 1$ indicates the exogenous degree of backwardness of the production of consumption goods in the South. For the mere sake of simplicity these technology parameters are held constant through the entire analysis. The production function can also be written as

$$Y^i = [n(x^i)^{\delta}]^{\gamma/\delta}[A^iL^{ic}]^{1-\gamma} \qquad i = 1, 2 \tag{1'}$$

Dividing by nx^i and rearranging, the function can be written as output per unit of intermediates depending on efficient labor per unit of intermediates

$$Y^i/(nx^i) = [n^{\gamma/\delta - \gamma}]\,[A^iL^{ic}/(nx^i)]^{1-\gamma} \quad i = 1, 2 \tag{1''}$$

The exogenous number of intermediates n now works like a Hicks neutral technology parameter with level $n^{\gamma/\delta - \gamma}$ if $\delta < 1$. The production function (1'') is drawn in Figure 1, panel (a).

In the monopolistic sector the quantity of each variety is produced with labor requirements

$$f + ax^j \quad j = 1, \ldots, n \tag{2}$$

f indicates fixed labor requirements. In Flam/Helpman (1987) they are interpreted as labor for Research and Development. In Markusen (1988, 1989) they are interpreted as labor for education, because x^j are interpreted as services provided by skilled workers.

The labor constraint, with labor supply L^2 in the North, is

$$L^2 = L^{2c} + \sum_{j=1}^{n} (f + a\,x^j) \tag{3}$$

The equilibrium value x^j will be either exported or used domestically, so that we have

$$x^j = x^{1j} + x^{2j} \qquad j = 1,\ldots,n \tag{4}$$

Labor market equilibrium in the South requires that labor demand in (1), L^{1c}, equals labor supply L^1, which in turn is given by population:

$$L^1 = L^{1c} \tag{5}$$

For the sake of simplicity we assume that individuals do only have preferences for consumption.

3. Optimal growth and the constant optimal size of the firm

The simplest way to derive all results of growth and structural change is to start from the central optimum and shift the question of subsidies which can bring it about to a later section. We use the same symbols for shadow prices as for market prices in the later sections. The objective function is the sum of consumed goods. Production functions and conditions of full resource use (1), (3) – (5) are the constraints of the optimum. Then, the Lagrangean for the world optimum of the model may be written as

$$L = Y^1 + Y^2 + \sum_{i=1}^{2} \lambda^i \{[\sum_{j=1}^{n} (x^{ij})^{\delta}]^{\gamma/\delta}[A^i L^{ic}]^{1-\gamma} - Y^i\}$$

$$+ w^2 \{L^2 - L^{2c} - \sum_{j=1}^{n} (f + ax^j)\} + \sum_{j=1}^{n} p \{x^j - x^{1j} - x^{2j}\} + w^1 \{L^1 - L^{1c}\}$$

First order conditions are

$$\partial L / \partial Y^1 = 1 - \lambda^1 = 0 \quad \text{and} \quad \partial L / \partial Y^2 = 1 - \lambda^2 = 0$$

The shadow price of goods equals unity because the objective function is formulated in terms of goods.

$$\partial L / \partial x^{1j} = \gamma Y^1 / (nx^{1j}) - p^j = 0 \qquad j = 1,...,n \tag{6a}$$

$$\partial L / \partial x^{2j} = \gamma Y^2 / (nx^{2j}) - p^j = 0 \qquad j = 1,...,n \tag{6b}$$

The marginal product of intermediates in both countries must equal the shadow price for intermediates in terms of goods.

$$\partial L / \partial L^{2c} = (1 - \gamma) A^2 Y^2 / (A^2 L^{2c}) - w^2 = 0 \tag{7a}$$

$$\partial L / \partial L^{1c} = (1 - \gamma) A^1 Y^1 / (A^1 L^{1c}) - w^1 = 0 \tag{7b}$$

The marginal product of labor must equal the shadow price of labor in terms of goods.

$$\partial L/\partial n = \Sigma\, \lambda^i\, (\gamma/\delta)(x^{ij})^\delta\, Y^i/[\Sigma(x^{ij})^\delta] - w^2(f + ax^j) = 0 \tag{8}$$

The sum of the marginal products of the number of varieties n must equal the value of labor demand for one variety in the monopolistic sector.

$$\partial L/\partial x^j = -\, w^2 a + p^j = 0 \quad j = 1,\ldots,n \tag{9}$$

Prices of intermediates should equal marginal costs in their production. and must be identical for all j. Therefore the index j is dropped henceforth.

The growth process can now easily be characterized. From (9) we find

$$\hat{w}^2 = \hat{p} \tag{10}$$

Where a " ^ " denotes "growth rate". Dividing equations (6) and (7) yields

$$p/(w^i/A^i) = \gamma A^i L^{ic}/[(1-\gamma)nx^{ij}] \quad i = 1, 2 \tag{11}$$

Constant technology parameters A^i therefore imply a constant labor intermediate ratio. Together with (6), (7) and (1") we therefore find

$$\hat{p} = \hat{w}^1 = \hat{w}^2 = \hat{Y}^i - \hat{n} - \hat{x}^{ij} = \hat{Y}^i - \hat{L}^{ic} = (\gamma/\delta - \gamma)\hat{n} \tag{12}$$

This formulation shows most clearly that a greater variety of intermediates for $\delta < 1$ takes over the role of technical progress via an increased division of labor as in Romer (1987) where U–shaped cost curves are used, whereas here average costs will be falling due to (2). Thus technical progress is transfered to the LDCs by monopolistic firms. If $\delta = 1$, this technical progress vanishes, because then the number of intermediates does not exhibit a larger elasticity of production than the quantity of the intermediates, which can be directly seen from (1) and (1'').

The consequences of higher n are summarized by broken lines in Figure 1: The production function is shifted upward at a constant level of $A^iL^{ic}/(nx^{ij})$. The zero profit line

$$Y^i/(nx^i) = p + (w^i/A^i)[A^iL^{ic}/(nx^i)$$

is a straight line with vertical intercept p and slope w^i/A^i which rotates around its horizontal intercept $\{-A^iL^{ic}/(nx^i) = p/(w^i/A^i)$, thus increasing the vertical intercept p and the slope of the zero profit line w/A^i.

To determine the optimal value of x^j, $\partial L/\partial n$ is multiplied by n which yields

$$(\gamma/\delta)[Y^1 + Y^2] - w^2(f + ax^j)n = 0 \tag{13}$$

If δ were equal to unity the value of the intermediates would have to equal the share of intermediates in final output. Due to the increasing returns induced by $\delta < 1$ the value of output must be higher.

Inserting the sum of equations (6) for identical x^j due to identical prices and production techniques

$\gamma[Y^1 + Y^2] = pnx^j$

into (13) we find

$$(1/\delta)pnx^j - w^2(f + ax^j)n = 0 \tag{14}$$

The equality $aw^2 = p$ then implies

$(1/\delta - 1)px = w^2 f$

Solving for x and using $w^2/p = 1/a$ again yields

$$x = f/[a(1/\delta - 1)] \tag{15}$$

The optimal quantity of each variety x is constant and independent of exogenous variables. As each variety in this type of model is produced by one firm this model does not support the view that firms have to grow during the growth process under increasing returns to scale.

4. The widening of the market increases the division of labor and induces structural change in trade, employment and production.

The model is well explained now up to the growth of the number of varieties which drives the whole process. This can only be done through the growth of population which is exogenous here. Insertion of the value of x into the labor market condition (3) yields:

$$L^2 = L^{2c} + nf/(1-\delta) \tag{3'}$$

The last term is the employment in the monopolistic sector, which grows at the rate $\hat{n}$.

Replacing labor inputs in the second equation of (11) according to (5) yields:

$$nx^1 = \gamma A^1 L^1/[a(1-\gamma)] \tag{16}$$

(3') in (11) yields

$$nx^2 = \gamma A^2[L^2 - nf/(1-\delta)]/[a(1-\gamma)] \tag{17}$$

(4), (16) and (17) are three equations for n, x^1 and x^2. Insertion of (4) for x^2 and then (16) for nx^1 into (17) and then replacing x by use of (15), provides the solution for n:

$$n = \frac{\gamma(1-\delta)(A^2L^2 + A^1L^1)}{(1-\gamma)f\delta + \gamma A^2 f} \tag{18}$$

Higher population of whichever country widens the market and leads to a higher number of firms. The consequences of higher number of firms had already been demonstrated in Figure 1. If δ hypothetically approaches 1 the impact of population on the number of firms approaches zero. The higher the fixed cost term f the smaller the number of firms which goes to infinity if f goes to zero. The closed economy case for country 2 can easily be considered if L^1 is put to zero in (18), which shows that n would be smaller or, equivalently, that trade leads to a greater variety of intermediates.

Structural change of the trade in intermediates can be analysed as follows. Inserting (18) into (16) yields the quantity exported by each firm of the monopolistic sector:

$$x^1 = \{ \frac{\gamma(1 - \delta)(A^2L^2 + A^1L^1)}{(1 - \gamma)f\delta + \gamma A^2f} \}^{-1} \gamma A^1L^1/[a(1 - \gamma)]$$

or after doing the multiplication by L^1

$$x^1 = \{ \frac{\gamma(1 - \delta)(A^2L^2/L^1 + A^1)}{(1 - \gamma)f\delta + \gamma A^2f} \}^{-1} \gamma A^1/[a(1 - \gamma)] \tag{19}$$

If population in the South grows faster than in the North, then the share of intermediates exported, x^1/x, will increase while x is constant. Relatively more people working in southern consumption goods production requires larger shares of the intermediates.

Structural change of employment can easily be analysed. Dividing (3') by L^2 we find directly the shares of the sectors in the labor force.

$$L^{2c}/L^2 = 1 - (L^2)^{-1}nf/(1 - \delta) \tag{3''}$$

Insertion of the optimal number of varieties yields

$$L^{2c}/L^2 = 1 - \frac{\gamma(1-\delta)(A^2 + A^1L^1/L^2)}{(1-\gamma)f\delta + \gamma A^2 f} f/(1-\delta) \tag{20}$$

If the South grows relatively faster than the North the share of employment of the monopolistic sector will increase and the share of employment of the competitive sector will decrease.

The analyses of structural change in production follows from that of employment. If the South grows faster than the North we found $dL^{2c}/dL^2 < 0$ and that x^1 grows and x^2 decreases. Thus, both factors in production of country 1 grow faster than the respective factors of the competitive sector of country 2. Thus, we must have

$$\hat{Y}^1 > \hat{Y}^2 \quad \text{if } \hat{L}^1 > \hat{L}^2 \tag{21}$$

In sum, if LDCs have higher population growth than DCs, the latter increasingly specialize in their innovative monopolistic sector, whereas the supply of the consumer goods is provided by the LDCs at an increasing rate.

5. Optimal subsidization in a market equilibrium

Which subsidy system can bring about the optimum? It is clear that equations (6a) – (7b) would result from a price taking profit maximization of the consumption goods industry. (8) has been transformed into (14) and up to the expression $1/\delta$ it would equal the zero profit condition of a monopolistic firm in a pure market economy. Moreover, (9) would not be the result of a pure market equilibrium but instead marginal revenue equal to marginal cost would be observed, containing the price elasticity of demand for intermediates which can be derived from the first order conditions of unit cost minimization of the consumer goods firms as

$$(\partial p/\partial x)(x/p) = -[(\gamma/(1-\gamma)+\delta]/n-(1-\delta) \tag{22}$$

The term including the number of firms is put to zero in Dixit (1984) and Flam/Helpman (1987) and others by assumption of a large number n and in Grossman/Helpman (1989a, b, c and 1990) by assumption of a continuum of intermediates. In the optimal model we had no problem with it due to the simplicty of (9). The question is now which subsidy can bring about the equivalence of (9) and (14) from the optimum with market equilibrium. To analyse that we write down the zero profit function for a combination[2] of ad valorem (s_1) and specific (s_2) subsidies and then compare these with (9) and (14). The zero profit condition then is:

$$[p(1+s_1)+s_2]\,x-w^2(f+ax)=0 \tag{23}$$

Making use of the elasticty (22) the equality of marginal revenue and marginal cost may now be written as:

$$(1+s_1)p\{1-[\gamma/(1-\gamma)+\delta]/n-(1-\delta)\}+s_2-aw^2=0 \tag{24}$$

Equality of the zero profit (23) condition with (14) requires

$$p/\delta = p(1 + s_1) + s_2 \quad \text{or} \quad s_2 = [1/\delta - (1 + s_1)]p \tag{25}$$

Equality of (24) with (9) requires

$$p(1 + s_1)\{-[\gamma/(1 - \gamma) + \delta]/n - (1 - \delta)\} + s_1 p + s_2 = 0$$

Insertion of s_2 from (25) yields

$$p(1 + s_1)\{-[\gamma/(1 - \gamma) + \delta]/n - (1 - \delta)\} + s_1 p + [1/\delta - (1 + s_1)]p = 0$$

Dividing by p after cancelling $s_1 p$ yields

$$(1 + s_1)\{-[\gamma/(1 - \gamma) + \delta]/n - (1 - \delta)\} + [1/\delta - 1] = 0 \tag{26}$$

In (26) n is given from (18). For (26) to hold, higher n requires higher s_1, impyling lower s_2 from (25). As n approaches infinity the ad valorem subsidy approaches

$$\lim_{n \to \infty} (1 + s_1) = 1/\delta \quad \text{implying } s_1 = 1/\delta - 1 \tag{27}$$

In this limiting case the specific subsidy is zero which can be seen from (25). The ad valorem subsidy should be equal to the measure of increasing returns or to the rate of technical progress divided by $\gamma\hat{n}$.

6. Rule of thumb policy, fixed cost covering, international distribution of subsidy financing and gains from trade

If (27) instead of (26) were used as a rule of thumb the economy would converge to an optimum in the long run.

Panel (b) of Figure 1 summarizes the behaviour of the monopolistic firm under optimal subsidies: At a constant value of x the marginal cost curve shifts up as n increases and is always intersected by demand at the same x. The marginal cost curve equaling the price is drawn as cc in Figure 1, panel (b).

From the zero profit condition (23) one can directly see that subsidies equal fixed costs:

$$(s_1p + s_2)x = w^2f \tag{28}$$

If fixed costs are interpreted as R&D costs as in Flam/Helpman (1987) this implies that the sum of optimal subsidies equals R&D costs. If fixed costs are interpreted as education costs as in Markusen (1988, 1989), this implies that the education costs are covered by the subsidies although it is payed as a production subsidy.

As countries face the same prices for the intermediates, and have the same number of intermediates available, the model contains relative wages identical to the ratio of labor augmenting technological coefficients. Total wage income – net of taxes to be payed for the subsidies in the developed country – will be consumed. Assume for a moment that $A^1 = A^2$. In this case wages net of taxes would be lower in the North than in the South if the North pays the taxes alone, whereas without subsidies and taxation wages would be equal.

This shows that the gains from subsidization are predominantly captured by the South, because they have the advantage of lower prices if they don't contribute to financing the subsidies which make intermediates cheap. In this model subsidies clearly raise a problem for international negotiations in regard of financing subsidies and determining the distribution of the efficiency gains, because if the non–contributing South were very small, this problem would not exist, but if the country is relatively large, and L^{2c} were small there is no guarantee that the net wages of the North would be higher under the subsidy.

The gains from trade are the increases in real wages net of subsidies which equal:

$$w^2L^2 - (ps_1 + s_2)x = w^2L^2 - fw^2 = w^2(L^2 - f)$$

To derive the first equation we have made use of (28). As higher n through population growth increases w^2, gains from trade are positive for the North under optimal subsidies even if they pay for them alone. For the South wages are increasing as the market is widened, improving their situation inspite of falling terms of trade.

7. Conclusion

The assumption of optimal subsidies allowed to solve the model without any resort to artificial assumptions like infinitely many products or even dropping terms which produce constant elasticity demand functions although it is much more plausible that the elasticities depend on the number of firms. As a consequence it was possible to analyse the reaction of size and number of firms and the optimal subsidies on the widening of the market and the structural change induced by population growth on production, trade and employment.

In this model the higher number of firms and therewith intermediates is identical to higher productivity through an increased division of labor.

The normative implications for practical policy are much less clear.

On the one hand subsidies are optimal. As a rule of thumb, it is therefore suggestive to advise ad valorem and specific subsidies whose sum should equal fixed costs or an ad valorem subsidy payed at the level of the measure of increasing returns.

On the other hand one might be afraid of such a large role for the government. The costs of government administration and democratic control (see Krueger, 1990) have not been incorporated into the model and may well be high. Here the experience of some of the developed countries like the Scandinavian ones and the Netherlands with sales taxes of roughly 20% are more encouraging to undertake such government action than the experiences of many underdeveloped countries. The relation between wealth, democracy and democratic control costs might be an interesting subject for future research and the question whether largeness of the government correlates negatively with efficiency may be an interesting part of it. A basic problem here is that the temptation of corruption as well as the profitability of incurring control costs may increase with the sum handled by civil servants.

Besides the political and administrative aspects it should be kept in mind that the financing of optimal output subsidies through taxation will raise excess burdens in more general models, which had been the subject of optimal taxation theory. It is unclear whether these excess burdens are larger or smaller than the gains from optimal subsidization.

The objections mentioned so far of course are also valid for all the trade policy measures in the literature (see Flam/Helpman, 1987, and Helpman/Krugman, 1989) and the subsidies in Markusen (1988).

The likelihood of achieving such an optimal subsidy may be reduced by the fact that the North cannot receive all the gains as was shown above. Payments of the South to subsidize intermediates production in the North are rather unlikely, at least if one allows for broader preferences than those of the model. If, however, the current trend of decreasing shares of the third world in world trade is continued, subsidization for the North alone may well pay.

Perhaps the most relevant aspect for practical purposes is that the reduction of subsidies strived at in recent policy will be much less beneficial in view of an increasing returns model than in view of constant–returns/first–best models which sometimes seem to be the basis for the expectations of returns to reduced subsidies. Of course, this is no argument against the reduction of export subsidies which produce prices that are higher at home than on the world market. But the gain here comes from dropping measures that produce biases and not from subsidy reduction in general. The whole question has, of course, to be separated from other problems like guaranteed prices for agricultural products.

Perhaps this analysis of optimal subsidies is a more valuable contribution to the literature on technical progress and new growth theory mentioned in Footnote 1 because there increasing returns which deserve subsidization here are always essential to the analysis, whichever specification is used.

Whichever the preferred view, it seems to be clear that optimal output subsidies in fixed cost models produce a further argument in favor of government action which have to be weighed against its cost. Therefore this weighing should be done in the framework of the more realistic increasing returns models.

References

Aghion, P. and P. Howitt (1989), A Model of Growth through Creative Destruction, Massachusetts Institute of Technology, mimeo, May.

Dixit, A. (1984), Growth and Terms of Trade under Imperfect Competition, in: H.Kierzkowski (ed.), Monopolistic Competition and International Trade, Oxford, Clarendon Press, 109 – 123.

Ethier, W. (1982), National and International Returns To Scale in the Modern Theory of International Trade, The American Economic Review, 72, 389 – 405.

Flam, H. and E. Helpman (1987), Industrial Policy under Monopolistic Competition, Journal of International Economics, 22, 79 – 102.

Grossman, G.M. and E. Helpman (1989a), Endogenous Product Cycles, NBER Working Paper No. 2913.

____________________ (1989b), Growth and Welfare in a Small Open Economy, Woodrow Wilson School, Discussion Paper No. 145.

____________________ (1989c), Quality Ladders and Product Cycles, Woodrow Wilson School, Discussion Paper No. 152.

____________________ (1990a), Comparative Advantage and Long Run Growth, The American Economic Review, 80, 796–815.

____________________ (1990b), Product Development and International Trade, Journal of Political Economy, 97, forthcoming.

Helpman, E. and P.R. Krugman (1989), Trade Policy and Market Structure, MIT Press, Cambridge, Massachusetts.

Krueger, A.O. (1990), Government Failures in Development, Journal of Economic Perspectives, 4, 9 – 24.

Lucas, R.E. (1988), On the Mechanics of Economic Development, Journal of Monetary Economics, 22, 3 – 42.

Markusen, J.R. (1986), Explaining the Volume of Trade, American Economic Review, 76, 1002 – 1011.

__________ (1988), Production, Trade and Migration with Differentiated, Skilled Workers, Canadian Journal of Economics, XXI, 492 – 506.

__________ (1989), Trade in Producer Services and in other Specialized

Intermediate Inputs, American Economic Review, 79, 85 – 95.

Neumann, M. (1989), Market Size, Monopoly Power and Innovations under Uncertainty, in: D.B. Audretsch, L. Sleuwagen and H. Yamawaki (eds.), The Convergence of International and Domestic Markets, North–Holland, Amsterdam.

Phelps, E.S. (1966), Models of Technical Progress and the Golden Rule of Research, Review of Economic Studies, 33, 133–45.

Romer, P.M. (1987), Growth Based on Increasing Returns due to Specialization, The American Economic Review, 77, 56 – 62.

________________ (1990), Endogenous Technical Change, Journal of Political Economy, Supplement, forthcoming.

Shell, K. (1967), A model of Inventive Activity and Capital Accumulation, in: Essays on the Theory of Optimal Economic Growth, in K. Shell (ed.), 67–85, Cambridge, Massachusetts, MIT Press.

Uzawa, H. (1965), Optimal Technical Change in an Aggregative Model of Economic Growth, International Economic Review, 6, No. 1, 1965, 18 – 31.

Ziesemer, T. (1991), Human Capital, Market Structure and Taxation in a Growth Model with Endogenous Technical Progress, Journal of Macroeconomics, Vol. 13, (forthcoming).

Footnotes

1 This has the additional advantage that no decision has to be made on the specification of the production function for the number of varieties. In regard to this latter point it might be interesting to note that Grossman/Helpman (1990b) use a production function similar to that of Phelps (1966) where the time derivative of the (measure of) the number of intermediates (the stock of knowledge) is made dependent on a linearly homogeneous production function. This leads to a vanishing of technical progress – in the steady state if population does not grow – as it did in Phelps model. In Romer (1990) and Grossman/Helpman (1990a, 1989a, b) the rate of growth of the (measure of) the number of intermediates (the stock of knowledge) is made dependent on a linearly homogeneous production function as it is in Shell (1967). This leads to a rate of growth of knowledge that is growing itself if primary resources grow as they do in Shells model. Both outcomes are counter–intuitive and the latter held to be undesirable by Aghion/Howitt (1988) but not by the other authors using it. Formulations used by Uzawa (1965), Lucas (1988), Neumann (1989) and Ziesemer (1991) make the rate of growth of knowledge dependent on variables that are constant in the steady state of neoclassical growth models, e.g. the share of labor in the educational sector in Uzawa's paper. This is held to be the best one here because it reproduces the Solow results without any resort to fixed factor supply assumptions. However, to make the model simple and let it not depend on issues upon which the views currently diverge so much, we assume that there are no costly blue prints. Therefore the effects of technical progress à la Ethier can be considered isolated from this issue.

2 Neither of the two subsidies alone can bring about the optimum (which the interested

reader may check himself), because there would always result a second determination of n or other contradictions.

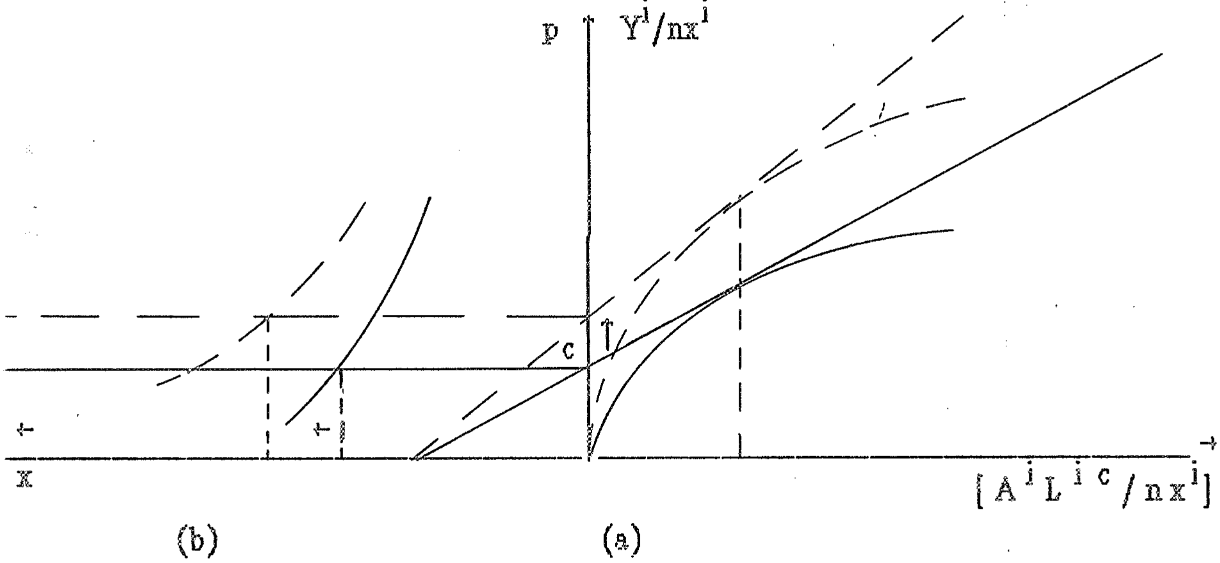

Figure 1