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International competition, growth and welfare

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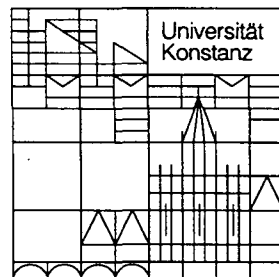
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Diskussionsbeiträge

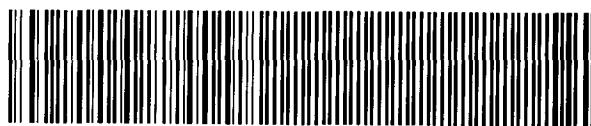
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Growth and Welfare**

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**International Competition,
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International competition, growth and welfare

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Opening up to trade exposes firms to new competitors. If foreign and domestic firms produce close substitutes, their interaction in the product market forces prices below the monopolistic level. This increased competition induces a shift of demand from monopolistic to oligopolistic varieties and thereby reduces incentives to develop new varieties. This reduces innovation activities and thus the growth rate. Competition always reduces welfare for both domestic and foreign consumers. If the scale and the intensity of competition are large, trade will reduce the welfare level even below the autarky level. Temporary, declining tariffs on all imports and permanent tariffs on oligopolistic varieties are instruments to improve welfare.

1. Introduction

It is a commonly expressed fear that increasing international competition harms economic prosperity as it necessitates long-lasting and painful restructuring of economies. Examples of these statements abound whenever trade liberalizations are under discussion, be it during the integration process within the EC, during the negotiations of the NAFTA or when trade negotiations with East Asian or East European countries are under way. The public debate about the effects of international competition on the domestic economy is fuelled by many issues. One example are distributional consequences which certainly motivate a large part of the political discussion. Other issues are e.g. job destruction and the extend to which new jobs are created. Without doubt, these questions are of importance for the development of an economy both from a distributional and an efficiency point of view. These issues can be nicely treated in the Heckscher-Ohlin model, the standard workhorse of international trade theory. Foreign firms have an advantage over their domestic competitors if factors of production used intensively are more abundant abroad and therefore cheaper. Inversely, some domestic firms have a competitive advantage over foreign firms on the basis of the same comparative advantage argument.

This way of capturing international competition is not the only one, however. In fact, it is the scope of this paper to propose an alternative way of how to perceive international competition and an alternative explanation where the above mentioned concerns may come from. The scenario we have in mind is the following. Imagine two countries that have no or little economic interaction with each other. Let both countries produce one final good that is available in different varieties. When

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diversifying their goods, entrepreneurs in both countries base their decisions not on goods produced and sold abroad but solely upon goods sold by domestic competitors. At some point in time, trade liberalization is announced and (possibly at a later date) free trade in goods sets in. Domestic firms can now freely sell their products abroad, as can foreign firms on the domestic market. Trade liberalization reveals that some goods produced domestically have close or even perfect foreign substitutes. Firms that were monopolists in their market under autarky, face competitors producing an identical variety under trade. This scenario of a changing market structure as a consequence of opening up to trade is the way increasing competition due to international trade is captured.

The impact of international competition is easily understood. Increasing competition between domestic and foreign firms leads to lower prices of now oligopolistically provided varieties. Demand will shift from monopolistic to oligopolistic goods. This reduces profits of existing monopolistic varieties and, more importantly, the expected return on investment in the development of a new variety. These lower R&D returns imply a lower innovation rate¹ which may even lead to a complete cessation of all innovative activity. Crucial factors are the degree of the overlap between varieties produced domestically and abroad, to be called scale of competition, and the intensity of competition. If countries are caught in a no-growth trap, but even if innovation continues, a decrease in the innovation rate leads to welfare losses due to an inefficient factor allocation. Welfare losses can be so strong that autarky is preferred to free trade. Corrective devices are a permanent or temporary tariffs.

This view of international competition provides new insights on the effects of international trade on growth and welfare. There are numerous findings on these relations and we give only a short overview. Starting with welfare effects, we recall the well-known result that in a world of perfect competition and no externalities, international inter-industrial exchange of goods increases the *social* welfare level of a country if national economies differ in factor endowments or technologies. The fact that international trade can also raise *individual* welfare levels, and hence the claim that trade is Pareto improving, can be demonstrated by either allowing for lump-sum transfers or taxes on factors of production and final goods (Dixit and Norman, 1986). In a world of monopolistic competition, intra-industrial exchange enhances welfare by expanding the range of available consumption or intermediate goods and through a stronger exploitation of increasing returns to scale (Krugman, 1979; 1981)².

Taking the effect of international trade on economic growth into account, generally confirms static considerations. Grossman and Helpman (1990, 1991) and Rivera-Batiz and Romer (1991), among others, have worked out many links through which trade can affect growth. The main growth enhancing mechanism in these R&D based growth models has turned out to be the international transmission of knowledge (Grossman and Helpman, 1991, ch. 8; Devereux and Lapham, 1994). Hence, with frictionless flows of information across borders, trade is, as compared to autarky, growth enhancing. Some circumstances can be imagined, however, where trade reduces a country's growth rate. Given, e.g., imperfect knowledge spillovers, Grossman and Helpman (1991, ch.8) show that the growth rate of an economy can steadily fall (to become zero in finite time). This does not necessarily mean, however, that this economy loses from trade. In other situations (Stokey, 1991) it is the effect of relative specialization on factor prices affecting human capital accumulation decisions that reduces growth. Welfare effects in this case are ambiguous.

Summing up, the literature – taken by and large – seems to support the view that public perception of potentially damaging effects of international competition is wrong. International trade is generally argued to increase growth and welfare. The present paper argues that drawing these conclusions based on these models would neglect the effect of increasing competition due to changing market structures.

¹ Growth rate and innovation rate will be used interchangeably in the text.

² Since we are interested in the change of welfare between no trade and trade, we neglect the optimal trade policy literature which discusses welfare effects of small impediments to trade such as optimal tariffs. See e.g. Helpman and Krugman (1989).

Apart from providing an alternative view of international competition, the paper also adds to the understanding of transitional phenomena that take place in an economy that opens up to trade. As is clear from the above summary, most of the international trade literature focuses on long-run aspects. Static models, even if lent a dynamic interpretation in the sense that these models describe long-run steady states, neglect the transition period setting in after opening up to trade. Phenomena of this period, however, are much more important for policy decisions than long-run effects. The same is true for dynamic trade models which are rarely used to study adjustment processes with a policy question in mind³. This paper provides a realistic example which shows that transitional aspects should not be neglected. Trade does increase the growth prospects of an economy and does increase its welfare level but only if suitable adjustment assistance mechanisms are taken during the transition period. Without these mechanisms, present value welfare losses are very likely to occur and even an economy's growth rate can permanently fall.

The next section presents the model. Section 3 and section 4, respectively, look at the effects of increasing international competition on growth and welfare. Section 5 studies the effects of permanent and temporary tariffs. Section 6 concludes.

2. The model

This section is subdivided into three parts. The first presents the starting point of the paper and shows how the idea of increasing international competition is captured. The second presents a simple two-country model of innovation and growth. The third part provides the autarky benchmark case and derives a reduced form of the model that will be used in subsequent sections.

2.1. Overlap of varieties

There are two countries, A and B , that have access to identical technologies and share common preferences. Both countries produce one differentiated final good using labour as the only rival input. Differentiation is a consequence of R&D activities that also requires labour as input but, in addition, benefits from a non-rival productive factor, a public stock of knowledge (Romer, 1990). The model we use can either be seen as a two-country version of Grossman and Helpman (1991, ch. 3.2) or a simplified version of Grossman and Helpman (1990) and we do not claim any originality in its setup. The main contribution is to present a concept of international competition and to analyze the timing of trade liberalization between countries. The reason why timing matters is illustrated in Figure 1.

Before opening up to trade, each country has already produced a certain range of varieties. As shown in Figure 1, $n^A = n_m^A + n_d$ is the number of varieties developed in country A and $n^B = n_d + n_m^B$ varieties originate from country B . Monopolistic varieties are indexed by m , duopolistic by d . When countries open up to trade, they find themselves in one of several possible situations. The simplest situation is one in which no overlap exists, $n_d = 0$. This is the situation usually analyzed in trade models. The arguments supporting such an assumption are, first, the absence of an incentive for market entrants to copy already existing varieties. If imitation is as costly as development of a new variety, profits a firm earns from a shared variety are lower than profits a market entrant receives if a new variety is developed⁴. A second, usually not explicitly spelled out,

³ There are some exceptions, of which Dellas and de Vries (1995) is a recent example. They focus on capital market liberalization schemes and show that under certain circumstances a step-by-step capital market integration leads to a higher long-run capital per labour endowment than would an instantaneous liberalization. Other examples are Edwards and van Wijnbergen (1986) and the papers in Bhagwati (1982).

⁴ Studies that consider imitation of already existing varieties include Segerstrom (1991) and Grossman and Helpman (1991b).

argument is that economic effects of international trade are studied for the long-run equilibrium. Any adjustment process that might set in after allowing for international trade can therefore be neglected.

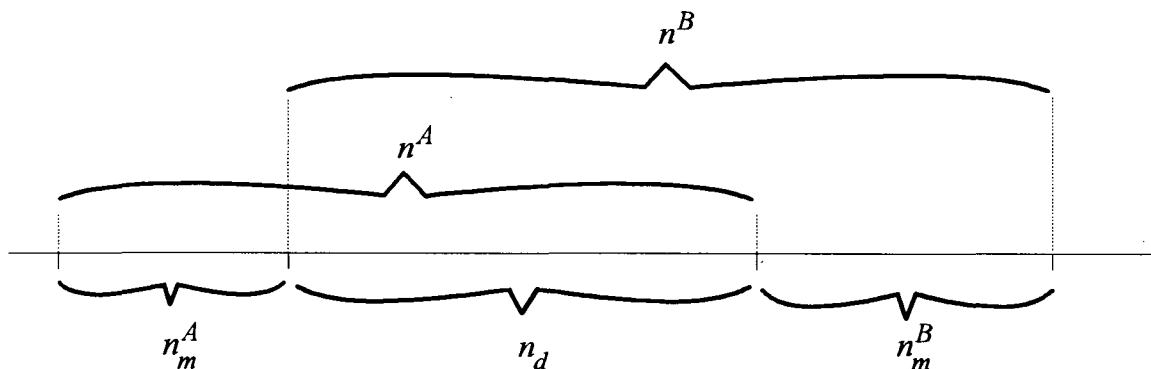


Figure 1: Overlap of varieties

Such a long-run perspective can be misleading. If one is interested in the effects of opening up to trade on welfare and growth shortly after the trade liberalization takes place, and this is certainly the focus of the more relevant policy discussions, the adjustment mechanisms should not be neglected. One factor playing an important role during the adjustment process is increasing competition in some markets. This situation is captured by allowing for an overlap, $n_d > 0$. In autarky, firms have incomplete information about markets abroad and little incentive to take varieties produced abroad into account in their R&D strategy. When trade opens up, it is revealed that some varieties produced at home are closer substitutes than others to those that had been developed abroad. In an extreme case, the one adopted here for simplicity, firms face new competitors in their own market which therefore has to be shared. Considering the possibility of an overlap allows to give a realistic interpretation of concerns about welfare and growth reducing effects of careless trade liberalization.

(One might be attempted to argue that such an overlap is impossible. Given the R&D technology, firms can, at no costs, avoid the development of varieties already produced by another firm. Hence, if firms assign positive probability to trade barriers being lifted in the future, they should avoid developing these varieties. Clearly, this can not be assumed for all trade situations at all times. Not all policy decisions can be anticipated, not all products of potential foreign competitors can be permanently studied and it might be profitable in autarky to *imitate* varieties produced abroad. These aspects appear realistic and intuitively clear and we therefore did not explicitly model them. Note further that an overlap of varieties would have effects even if autarky imitation of *domestic* varieties took place. Market sharing could become relevant for a larger number of varieties or the number of competitors in one market could increase from two to three or four.)

For the sake of clarity of the following exposition of arguments, it is useful to distinguish different types of overlap: complete one-sided overlap, complete two-sided overlap and (normal) overlap. A complete two-sided overlap of varieties is one in which every domestic firm has a competitor abroad and vice versa. The world economy has no monopolistically provided varieties at the moment countries open up to trade, $n_m^A = n_m^B = 0$. A complete one-sided overlap is a situation where all firms in one country have a direct competitor abroad, but the number of varieties produced abroad exceeds the number of domestic varieties, hence, some monopolistic varieties are left over, $n_m^A = 0$ and $n_m^B > 0$ or vice versa. There is (normal) overlap if both countries produce some monopolistic varieties.

Once countries have started to trade, the argument that monopolistic markets remain monopolistic and no imitation occurs is valid here, as well. Hence, the overlap is a feature of trading economies inherited from the past. The number of duopolistic varieties n_d will stay constant as soon

as countries trade with each other and can therefore be treated as a parameter. The total number of varieties available for consumption n is the sum of monopolistic and duopolistic varieties, $n = n_m^A + n_m^B + n_d$. The number of firms in country i ($i = A, B$) is made up of monopolists and duopolists, $n^i = n_m^i + n_d^i$ hence the number of firms in the world exceeds the number of varieties by the overlap, $n^A + n^B = n + n_d$.

2.2. The basic model

We will now give a brief description of the model, more details can be found in Grossman and Helpman (1991). Countries are assumed to be at or after a certain point in time t_{trade} when they start to interact by trading final goods and financial capital. Utility of a consumer living in country i at time t stems from a stream of future consumption, discounted at the time preference rate ρ , and is given by

$$U^i(t) = \int_t^\infty \exp[-\rho(\tau - t)] \ln C^i(\tau) d\tau. \quad (1)$$

The consumption index $C^i(\tau)$ depends on consumption of varieties k of a differentiated final good x produced in both countries and is given by $C^i(\tau) = \left(\int_0^n x(k)^\alpha dk \right)^{1/\alpha}$, $0 < \alpha < 1$. With perfect capital markets a world wide identical interest rate $r(t)$ leads to expenditure growth that is the same for all consumers,

$$\frac{\dot{E}^i(t)}{E^i(t)} = r(t) - \rho. \quad (2)$$

Anticipating both the symmetry property that all varieties are equally priced within a country (since all firms have access to the same technology) and international factor-price equalization (which will be shown below), total demand for a variety is given by

$$x_j = \frac{(p_j)^{-\varepsilon}}{n_m (p_m)^{1-\varepsilon} + n_d (p_d)^{1-\varepsilon}} (E^A + E^B). \quad (3)$$

The index j indicates whether a variety is monopolistically or duopolistically provided, $j = m, d$, prices are denoted by p and $\varepsilon = 1/(1 - \alpha) > 1$ is the demand elasticity.

The production side is characterized by two activities: production of varieties for which blueprints have already been developed and development of new blueprints. The production process takes place under constant returns to scale and follows the simplest production function possible, $x(k) = L_{x(k)}$, where $L_{x(k)}$ stands for the quantity of labour allocated to the production of variety k .

Since the technology is identical for all varieties, they are all priced, if monopolistically provided, at $p_m = w/\alpha$,

where w is the wage rate. Since the outcome of the model implies factor price equalization, all monopolistic varieties in the world economy have the same price. The profit maximizing price of a duopolistically provided variety, that is produced with the same technology as a monopolistic variety, is given by

$$p_d = w/m, \quad (4b)$$

where m^{-1} is the markup that depends on the intensity of competition between firms in this market.

When countries trade, new firms will enter the market by developing new unique varieties only. The development of blueprints for these varieties requires the allocation of a certain quantity of

labour and some knowledge which is freely available for all innovation activities. The production function reads

$$\dot{n}_m^i = \Lambda L_R^i K_n, \quad (5)$$

where K_n is the international stock of knowledge, L_R^i is the quantity of labour allocated to R&D in country i and Λ is a productivity parameter of labour. It is known from the work of Grossman and Helpman that this parameter is labour augmenting and has the same growth effect as if the economies labour force increased by a factor of Λ . Having this in mind, we normalize Λ to unity. Knowledge results as a by-product from the R&D activity and is assumed to be proportional to the number of different varieties available in the world economy. Hence, varieties that are produced twice contribute only once to the stock of knowledge, $K_n = n = n_m^A + n_m^B + n_d$. Free market entry drives pure profits to zero which means that the present value v_m of the profit stream resulting from the development of a blueprint for a new monopolistic variety equals its development costs,

$$v_m = c_R^i = w/K_n. \quad (6)$$

The value of such an innovation of a new monopolistic variety equals, in a perfect-foresight equilibrium, the discounted sum of its future profits,

$$v_m(t) = \int_t^\infty \exp[-(R(\tau) - R(t))] \pi_m(\tau) d\tau, \quad (7)$$

where profits are $\pi_m(\tau) = (1 - \alpha)p_m x_m$ and $R(u) = \int_0^u r(s) ds$.

Finally, the full employment condition for the factor market requires that demand for labour of the R&D sector and of the production process of monopolistic and duopolistic varieties equals its fixed supply L^i . Letting s^i denote the share in world demand for a duopolistic variety covered by the firm in country i , we obtain

$$L_R^i + L_m^i + L_d^i = \frac{\dot{n}_m^i}{K_n} + n_m^i x_m^i + n_d s^i x_d = L^i. \quad (8)$$

2.3. Preliminary steps

Before studying the effects of international competition on growth or welfare itself, some preliminary analysis is necessary. This subsection will first focus on the autarky situation that will be used as a benchmark case for comparisons of growth rates or welfare levels. It then gives necessary conditions for factor price equalization to hold right from the moment countries open up to trade. Finally, the reduced form of the model that will be used for the subsequent analysis is presented.

The autarky benchmark case

Since it is the scope of this paper to understand changes in an economy caused by international competition, an autarky point of reference for comparison of growth and welfare levels is needed. In the present setup, trade affects economies through three channels. The trade in goods effect which increases the number of varieties available for consumption, the trade in capital effect which allows intertemporal consumption smoothing and an increase in the stock of knowledge available from abroad. The scope of this paper is to determine the effect of international competition through trade in goods on growth and welfare. The ideal benchmark case would therefore be one that includes already the other two effects such that comparison of trade and autarky properties shows the effect of international competition only. To achieve this, we allow for knowledge spillovers in autarky, already⁵. Unfortunately, the present setup does not allow a distinction of consumption smoothing

⁵ This does not ignore neither question empirical results as e.g. Coe and Helpman (1995) who show that foreign R&D capital is more beneficial to domestic productivity the more open an economy is to foreign trade. Our counterfactual assumption that we allow for beneficial effects already in autarky is entirely analytically motivated

effects from competition effects⁶. Since the former are welfare increasing, however, potential welfare losses through trade found later are even stronger, if consumption smoothing was not allowed for.

Allowing for autarky knowledge spillovers leads to an innovation rate in autarky that exceeds its counterpart of a closed economy with no spillovers by $\frac{L^i}{L} \frac{K_n}{n^A + n^B}$. This term is the size of a country

relative to the size of the world economy, $L = L^A + L^B$ times the ratio of R&D knowledge available for production to the number of firms in the world economy. Hence, the autarky innovation rate is higher, the more knowledge per variety is generated, in other words, the less redundant R&D is. It reads,

$$g^A = g^B = (1 - \alpha) \frac{K_n}{n^A + n^B} L - \alpha \rho. \quad (9)$$

An implication of allowing for autarky spillovers is that the ratio of number of varieties per worker are identical for every country,

$$n^A / L^A = n^B / L^B. \quad (10)$$

An economy's autarky welfare level can be easily computed by inserting equilibrium properties for the number of varieties and consumption into the utility function (1). Since there is no trade, an economy's consumption level per variety equals output of the representative firm. Relevant equilibrium properties are then $n^i(\tau) = n_0^i \exp[g^i(\tau - t_0)]$ and $x^i(\tau) = x_0^i \exp[-g^i(\tau - t_0)]$, where g^i is the economy's constant autarky innovation rate. In that case, the present value of the welfare level of country i in autarky is a function of the number n_0^i of varieties available at the moment when utility is evaluated, the corresponding consumption level x_0^i , the innovation rate and parameters,

$$U_{aut.}^i = \frac{1}{\alpha \rho} \left(\ln(n_0^i) + \alpha \ln(x_0^i) + \frac{1 - \alpha}{\rho} g^i \right). \quad (11)$$

The consumption level can be directly read of the factor market clearing condition,

$$x_0^i = (L^i - g^i) / n_0^i. \quad (12)$$

Factor price equalization

The mechanism of factor price equalization here is similar to one in models of comparative advantage due to differing factor endowments. Since both countries produce with identical technologies, both in the production and in the R&D process⁷, factor rewards equal if output prices equal. Assume that monopolistic firms in, say, country A charged a higher price for varieties than firms in country B . Then, demand for varieties produced in country A and real returns would be lower, $\pi_m^A / v_m^A < \pi_m^B / v_m^B$. Since the costs of financing R&D is the same for every investor due to perfect capital markets, these lower returns would have to be compensated by higher growth of firm values in country A . Since higher growth of firm values feeds back to lower real returns and therefore causes still higher growth of firm values, this is a contradiction to long-run equilibrium properties of the model, where firm values equalize. Hence prices of monopolistic varieties must instantaneously equalize at the moment countries open up to trade, which leads to an instantaneous equalization of wages.

Following the lines in Wälde (1995), this can be proved formally as follows. Differentiating (7) with respect to time gives the usual 'no-arbitrage' condition $\dot{v}_m^i / v_m^i = r - \pi_m^i / v_m^i$. With

in order to be able to focus on the effects of competition. It helps to keep the analysis as simple as possible and does not have any impact on the validity of the basic results.

⁶ The effects of consumption smoothing in models of the type used here are studied in Wälde (1995).

⁷ Note that international perfect knowledge spillovers are crucial for internationally identical R&D technologies. If international spillovers were restricted, the following factor price equalization argument would break down.

internationally identical interest rates, this is equivalent to saying that the value of a firm in country A grows the faster, the higher its level, $\dot{v}_m^A/v_m^A > \dot{v}_m^B/v_m^B \Leftrightarrow v_m^A > v_m^B$ ⁸. Since on the balanced growth path firm values of monopolistic firms equalize, there can be an equilibrium only if $v_m^A = v_m^B \forall t$, which means factor price equalization on any path that leads to the balanced growth path.

This proof of factor price equalization employs equation (6) which says that R&D is profitable in both countries. If R&D stopped in, say, country B , the value of a firm entering the market, would be lower than its development costs, $v_m < w^B/K_n$, (6) would be violated and factor prices would not equalize. Hence, the results presented in the following are derived subject to the assumption of factor price equalization. In general, this assumption does not present any limitations to the validity of the arguments. It will be noted, where the assumption becomes crucial.

The reduced form

The behaviour of the world economy can be easiest analyzed by using a differential equation system in two auxiliary variables. One is the ratio of the number of different varieties to the number of duopolistically provided varieties, $\eta \equiv (n_m + n_d)/n_d = n/n_d$. The other one is the ratio of nominal world expenditure to the wage rate (which equals the product of the number of different varieties and the value of a monopolistic firm), $\delta \equiv E/w = E/(nv_m)$. Letting further μ denote the relative price between a monopolistic and a duopolistic variety (4), $\mu \equiv p_d/p_m$, the system reads⁹,

$$\frac{\dot{\eta}(t)}{\eta(t)} = L - \alpha \left(1 + \frac{\mu^{-\varepsilon}(1-\mu)}{\eta(t) + \mu^{1-\varepsilon} - 1} \right) \delta(t) \quad (13)$$

$$\frac{\dot{\delta}(t)}{\delta(t)} = \delta(t) \left(1 + \frac{1 - \mu^{1-\varepsilon} - \alpha(1 - \mu^{-\varepsilon})}{\eta(t) + \mu^{1-\varepsilon} - 1} \right) - \rho - L \quad (14)$$

This reduced form of the *integrated* world economy was chosen since understanding the adjustment process of the world economy as a whole is sufficient for understanding effects we are interested in. The change of the world innovation rate due to opening up to trade can be derived, as well as welfare effects of free trade on individual countries. Studying growth effects for individual countries is straightforward for the symmetric case where $L^A = L^B$ but is intractable for asymmetric countries¹⁰.

3. International competition and growth

We are now in a position to study the effects of increasing international competition on the growth performance of a country. In a first subsection, the long-run effects as well as outcomes in the case of collusion between competitors and if varieties do not overlap, are presented. The second subsection discusses the general case of an overlap.

⁸ $\dot{v}_m^A/v_m^A > \dot{v}_m^B/v_m^B \Leftrightarrow -\pi_m^A/v_m^A > -\pi_m^B/v_m^B \Leftrightarrow p_m^B x_m^B/v_m^B > p_m^A x_m^A/v_m^A \Leftrightarrow x_m^B > x_m^A \Leftrightarrow p_m^A > p_m^B \Leftrightarrow v_m^A > v_m^B$.

⁹ The first equation is found by inserting (8) into $\dot{\eta}/\eta = \dot{n}_m/K_n = \dot{n}^A/K_n + \dot{n}^B/K_n$. The second by differentiating (7) with respect to time and inserting this plus demand equations into $\partial \ln \delta / \partial t$ and rearranging.

¹⁰ The adjustment process of countries that differ in size and further catching-up features of models of this type was studied in Wälde (1995). The possibility of overlaps was not considered, however.

3.1. Long-run effects, collusion and no overlap

Given the fact that no copying of already existing varieties will take place once countries have opened up to trade, the share of duopolistically provided varieties in the number of all varieties continuously declines and will eventually become negligibly small. Hence, in the long-run, the world economy's growth rate will be the same as if no overlap of varieties existed. The same growth rate and a nearly identical factor allocation will be observed if duopolists collude and set their common output such that they maximize joint profits. This means that with respect to growth rates under free trade, one can jointly analyze a situation of no overlap, collusion and the long-run.

The long-run is captured by $\eta = (n_m + n_d)/n_d$ becoming large as the number of duopolistically provided varieties is constant and new firms enter the market. This gradually reduces "the importance of the brackets" in (13) and (14) which vanish as η approaches infinity. It is then easy to see that the integrated world economy eventually finds itself on a balanced growth path with a constant innovation rate of

$$g^w = (1 - \alpha)L - \alpha\rho. \quad (15)$$

In the case of no overlap, $n_d = 0$, the auxiliary variable $\eta = (n_m + n_d)/n_d$ is infinity and the brackets in both (13) and (14) vanish. The growth rate is again given by (15). The same is true if firms collude. In this case, duopolists maximize joint profits and charge a price equal to the one of monopolists. As a consequence, $\mu = p_d/p_m = 1$ and, again, brackets in both equation (13) and (14) vanish.

There are differences in the comparison of these situations with autarky, however. If there is no overlap, trade does not increase the growth rate since, already in autarky, firms enjoy international spillovers and growth rates in (9) and (15) are the same. If there is an overlap and firms collude, the innovation rate immediately jumps from its autarky (9) to its trade value (15). The main difference between autarky and free trade of goods is that there is the incentive to differentiate new products from other, domestic and foreign, products. Trade avoids duplicative R&D and thus improves the allocation of resources and the productivity of labour. The extra labour is both used for the production of final goods and employed in the R&D-sector, so that the growth rate is higher in the case of trade than in the case of autarky.

The fact that the long-run growth rate under trade exceeds the autarky growth rate even in the presence of an overlap and independently of the propensity of duopolists to collude, establishes that trade in goods increases the growth rate in the long-run. The difference to a situation of collusion or no overlap is of course that duopolistically provided varieties always exist and that there will always be price differential $\mu < 1$.

3.2. Competition and growth

International competition is a two-dimensional phenomenon. The first dimension, the *scale* of competition, is a consequence of the changing market structure scenario described so far. It increases, the higher the overlap as captured by $n_d/n (= \eta^{-1})$. The second dimension is the *intensity* of competition within a market. This competition between firms will be captured by the price ratio of monopolistically to duopolistically supplied varieties, $\mu = p_d/p_m$. Fiercer competition implies a lower price p_d of a duopolistic variety and a lower price ratio μ . The intensity of competition will be treated as a parameter. The scale of competition, however, is the state variable of the two-country world (13). If countries innovate under free trade, the scale of competition will gradually reduce, whereas the intensity does not change.

Most of the analysis of growth and welfare effects will be performed in terms of the general measure μ for the intensity of competition. In some cases, however, it is useful to have some

benchmark cases at hand. Different market structures and their implications for the price ratio and the markup are summarized in Figure 2.

Intensity of competition	Markup m^{-1}	Price ratio $\mu = \alpha m^{-1}$
Bertrand	1	α
Cournot	$2(1 + \alpha)^{-1}$	$2\alpha(1 + \alpha)^{-1}$
Collusion	α^{-1}	1

Figure 2: Intensity of competition, markups and relative prices

Under Bertrand-competition, prices of duopolistic varieties equal the wage rate. Hence, the mark-up is unity and the price ratio equals the inverse of the markup of monopolists. Under Cournot-competition, the price of a duopolistic variety is higher than the Bertrand price but lower than a price charged by a monopolist¹¹. In the case of collusion, the duopolists behave like one firm and hence choose the monopolistic price. The cases of Bertrand-competition and collusion provide upper and lower bounds, respectively, for the intensity of competition. The more intense competition, the lower the price ratio, $\alpha \leq \mu \leq 1$.

The evolution of the world economy

With a relative price of $\mu < 1$, the evolution of the integrated world economy in terms of the auxiliary variables as used in (13) and (14) can be illustrated with the help of Figure 3.

The horizontal axis shows the ratio of different varieties in the world as a whole to the number of duopolistically provided varieties, $\eta = n/n_d$. It ranges from 1 to infinity. The vertical axis plots the ratio of nominal world expenditure to the value of R&D times the number of different varieties, $\delta = E/(nv_m)$. The zero-motion lines $\dot{\eta} = 0$ and $\dot{\delta} = 0$ depict combinations of η and δ for which the change in η and δ , respectively, are zero. The intersection point of these lines,

$$\underline{\eta} = (\mu^{-\varepsilon} - 1) \frac{\alpha \rho}{(1 - \alpha)L - \alpha \rho} \quad (16)$$

determines the threshold level, below which the world economy is caught in a no-growth trap. If the scale of competition is too big, i.e. if there are too few monopolistic relative to duopolistic varieties ($\eta < \underline{\eta} \Leftrightarrow n_m < (\underline{\eta} - 1)n_d$), innovation in both countries comes to a halt¹². Keeping the scale of

¹¹ Under Cournot competition, each firm takes output of the other firm as given. Optimal quantities are then implicitly defined by $p(1 - (2\varepsilon)^{-1}) = w$, where the fact has been used that with equal marginal costs due to factor price equalization, the market share of each firm is one half.

¹² The derivation of the reduced form (13) and (14) rests, as stressed before, on the assumption of factor price equalization, which in turn requires positive innovation rates in both countries. Hence, the phase diagram is drawn under this assumption as well. The intersection point (16), therefore, has this expression only if both countries innovate if and only if $\eta > \underline{\eta}$. This is certainly the case for the symmetric case where $L^A = L^B$. If a situation is considered where the world economy starts trading and all investment is concentrated in, say, country *A*, the system to be analyzed consists of two differential equations plus the factor market clearing condition of country *B* with $\dot{n}^B = 0$. Such a system does not lend itself to a straightforward analysis, since the value of the threshold level $\underline{\eta}$ is given implicitly only by an analytically intractable equation system. Inspecting this system, however, shows

competition fixed, the probability that two countries are caught in such a trap depends on a variety of influences that are visible in equation (16). The most important one is the intensity of competition between foreign and domestic firms in the duopolistic market as captured by the relative price of duopolistic to monopolistic goods μ . The fiercer competition, the smaller the price ratio μ and the further the threshold level $\underline{\eta}$ shifts to the right. If competition is too fierce, i.e. μ becomes too small for an initial value of η_0 , innovation activity stops. On the other hand, if firms collude and $\mu = 1$, the threshold level is nil and the trap disappears. The probability of the occurrence of a no-growth trap depends further on parameters that influence the world economy's growth rate. The higher the world innovation rate in the denominator of (16), the further the threshold level moves to the left and the less likely an economy is trapped in a no-growth situation. A no-growth trap is – naturally – less likely to occur if the willingness to save and the productivity of labour in R&D are high and new varieties are highly valued.

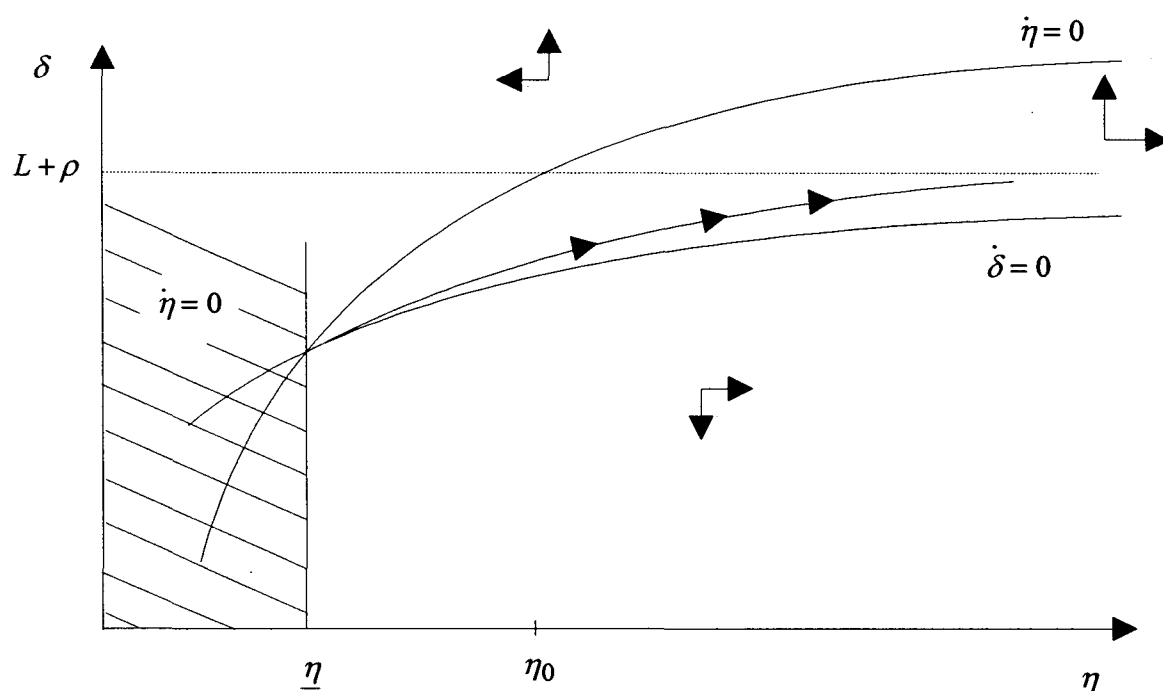


Figure 3: The integrated world economy

(One should not misinterpret the no-growth trap as the central prediction of the model. Clearly, this would have very little empirical support. It should rather be seen as a benchmark case whose analysis provides useful insight into the basic mechanisms underlying the general argument.)

If an initial value η_0 exceeds the no-growth trap value $\underline{\eta}$, the world economy finds itself on the saddle path that starts from the intersection point of the zero motion lines and approaches the horizontal line $L + \rho$ from below. This line gives the long-run balanced growth path value of δ . All other trajectories can as usually be ruled out by showing that they violate either the transversality condition of the maximization problem for the representative household or non-negativity conditions.

that the basic trade-offs pointed out in the main text are unaffected and that qualitative results remain untouched. The derivations are available from the authors upon request.

The mechanism that leads to either a halt of innovation activity or to a dampening is easily understood. Trade induces competition between suppliers of duopolistic varieties, erodes monopolies they used to have and forces prices of these varieties to fall below prices of monopolistic varieties. The demand shift from monopolistic to duopolistic varieties is stronger, the higher competition between duopolists as can be seen from relative demand, derived from (3), $x_d/x_m = (p_d/p_m)^{-\varepsilon} = \mu^{-\varepsilon}$. This alters the allocation of resources not only among production of currently available varieties, but, as a consequence, also from investment to production. The change in demand at the expense of monopolistically supplied varieties diminishes profits of monopolists and therefore the reward for new market entrants, given by the stream of future profits. This reduces the attractiveness to start new enterprises and hence dampens R&D activity which might even stop completely. In the case of positive innovation after opening up to trade, hence if the overlap is not too large, $\eta_0 > \underline{\eta}$, the introduction of new products paves the way for innovation later. Consumers have a taste for variety and spread expenditure over all available products. Expenditure is constantly reallocated from already existing to new products and the share of expenditure on common varieties in total expenditure decreases. The effect of competition on the structure of demand becomes less and less important, as new and unique products are launched on the goods market. The implication for the innovation rate is that it increases over time and approaches the rate in the case of equally priced products (15) in the long run.

Growth rates after opening up

It is interesting to see that opening up to trade leads for *any* scale of competition to a decrease of the innovation rate if the intensity of competition is too high. An example for this statement is provided here for the case of Bertrand competition, the strongest form of competition between firms. The innovation rate under free trade is given by $\dot{n}/n = \dot{\eta}/\eta$ in (13). Though this expression is not easily compared to the autarky growth rate (9), an upper and lower boundary can be found by exploiting the boundary values given for $\delta(t)$. Equation (13) shows that the innovation rate is the higher, the lower, ceteris paribus, the value of $\delta(t)$. An upper boundary for $\delta(t)$ is given by its long-run value $L + \rho$ which can be found by setting $\dot{\delta} = 0$ (which is the balanced growth path property of δ) and $\eta \rightarrow \infty$ in (14). This can be seen by inspecting Figure 3, which includes this long-run value as a horizontal line, and noting that the actual value of $\delta(t)$ follows the saddle path. This Figure further shows that the value of $\delta(t)$ is bounded from below by the value it takes on its zero-motion line $\dot{\delta} = 0$. Hence, *upper and lower* boundaries for the innovation rate can be obtained by inserting *lower and upper* boundaries of δ into (13). The lower boundary of δ is obtained by solving $\dot{\delta} = 0$ in (14) for δ . After some rearrangement, one finds that the growth rate after trade sets in is bounded from above as

$$\frac{\dot{\eta}(t)}{\eta(t)} = \frac{\dot{n}(t)}{n(t)} \leq g^w - (L + \rho)(1 - \alpha) \frac{\alpha(\mu^{-\varepsilon} - 1)}{\eta + \alpha(\mu^{-\varepsilon} - 1)}.$$

Comparing the autarky innovation rate (9) to the upper boundary of the trade innovation rate shows¹³ that the autarky innovation rate is higher than the trade innovation rate if $\alpha(\mu^{-\varepsilon} - 1) \geq 1$. Solving this equation for μ and plotting it with α on the x-axis shows that $\mu > \alpha \forall \alpha \in]0, 1[$. Since this estimation of an upper boundary was fairly rough, the result can be generalized. If competition is too fierce, hence the relative price is too low, the growth rate at the moment countries open up to trade is lower than the autarky growth rate.

¹³ The autarky innovation rate exceeds the trade innovation rate if $\eta(z - a) < a(1 - z)$, where $z = L/(L + \rho)$ and $a = \alpha(\mu^{-\varepsilon} - 1)$. If $a \geq 1$, then the LHS is negative since $z < 1$.

Again, there are two mechanisms at work. One increases the growth rate after opening up to trade, one is growth reducing. Growth is increased since no R&D is carried out twice and the stock of knowledge grows at the same rate as the number of varieties. As can be seen from the autarky growth rate expression (9) it is precisely this gap between knowledge K_n and number of firms $n^A + n^B$ that keeps the autarky innovation rate low¹⁴. Growth is reduced due to the competition effect described above. If the latter becomes too strong, the growth rate at the moment countries open up to trade falls below the growth rate in autarky.

Trade and country size

A further implication of the importance of the scale of competition as captured by η is that trade among countries with very unequal size is not very likely to have strong innovation decreasing effects. If the number of varieties differs between countries at t_{trade} , the number of duopolistic varieties is always below the number of varieties produced in one country before opening up to trade, $n_d \leq \min \{n_m^A + n_d, n_m^B + n_d\}$. Hence if a small country is included in an already existing trade union – think of an enlargement of the EC towards East Europe –, little innovation or welfare losses are to be expected. It will be shown in the following section, however, that there are nevertheless gains from managed trade liberalization. On the other hand, if countries of approximately the same economic importance (size) begin to trade, more far-reaching consequences can be expected.

Growth and competition

Two recent papers by Aghion and Howitt (1995) and Aghion, Dewatripont and Rey (1995) investigate the effects of competition in the final goods market on innovation activity in a closed economy context. They find that increasing competition has ambiguous effects on innovation. Their motivation are empirical studies by Blundell, Griffiths and Van Reenen (1995) and Nickell (1995) which also tend to an ambiguous conclusion on the effects of competition on growth. Our study differs from the one by the above authors in at least two respects. First, we focus on international trade as a source of increasing competition. Second, we compute welfare implications, explicitly focus on dynamic adjustment mechanisms and do not restrict our attention to the long-run. This transition perspective leads to the prediction that there is no one-to-one mapping from competition (as e.g. measured by market shares) to innovation activity and growth since the quantity of innovation activity is determined not only by competitive conditions within one market but also in other markets. In the short-run, when the demand diverting effect of the scale of competition is large, innovation is dampened, in the long-run, when the demand diverting effect tends to disappear, innovation activity goes back to its previous level. The intensity of competition and therefore the market shares remain unchanged, however.

4. International competition and welfare

Do falling innovation rates due to international competition give reason to worry about welfare effects? Can a country after having started to trade be worse off than in autarky? This section will discuss under what circumstances trade reduces welfare.

The first subsection studies welfare effects of trade if countries find themselves in the no-growth trap after opening up to trade. In a situation of a complete two-sided overlap countries will experience losses from trade. In the case of a one-sided overlap the same will generally hold. Welfare

¹⁴ We do not ask the question why there is an overlap in autarky. Arguments can be chance, ignorance or imitation. Since we want to study the effects of international competition as captured by overlapping varieties, there must be an overlap already in autarky. The reason we allow for knowledge spillovers in autarky is a technical one as discussed in subsection 2.3..

losses are larger for the larger country. If there is a normal overlap, the result depends on the importance of counteracting effects. In a second subsection, the welfare effects of free trade are studied for the general case where countries continue to innovate under free trade. It will be shown that international trade is welfare inferior to autarky if the scale of competition is above a certain threshold level.

4.1. Welfare in the no-growth trap

Statements about welfare improving or deteriorating effects of international trade can be derived by comparing the welfare level of a country under trade and autarky. Free trade welfare levels can be computed the same way as was the autarky level in (11). Given that the integrated world economy finds itself in a no-growth trap, the number of firms and therefore also the size of the firms is constant. The expression of the welfare level therefore loses, compared to the autarky expression, the term reflecting an ongoing innovation process but receives an additional one since trade requires a distinction between monopolistic and duopolistic varieties. The analysis of trade here further requires an explicit distinction between output of firms and consumption levels. Consumption in country i of a monopolistic variety produced in country l will be denoted by $c_m^{i,l}$. The utility function (1) becomes

$$U_{trade}^i = \frac{1}{\rho\alpha} \ln \left(n_m^i (c_m^{i,i})^\alpha + n_m^l (c_m^{i,l})^\alpha + n_d (c_d^i)^\alpha \right). \quad (17)$$

In contrast to a growing world economy, the no-growth trap does not guarantee factor price equalization as will become clear from studying the production side. Total demand for a variety k that could be easily expressed in (3) now depends not only on the market structure j under which they are produced but also on their country of origin i ,

$$x(k) = \frac{(p_j^i)^{-\varepsilon}}{n_m^A (p_m^A)^{1-\varepsilon} + n_m^B (p_m^B)^{1-\varepsilon} + n_d (p_d)^{1-\varepsilon}} E, \quad p_j^i = p_m^A, p_m^B, p_d. \quad (18)$$

On the production side, the number of monopolistic and duopolistic varieties, n_m and n_d , respectively, is given from the time before countries started trading. Total demand for each duopolistic variety is covered by production that is shared between countries. With Cournot-competition¹⁵, the optimal output of a firm producing in country i is implicitly given by

$$p_d (1 - s^i / \varepsilon) = w^i \quad (19)$$

where s^i is the share in total demand covered by the duopolist producing in country i . Note, that though free international trade enforces the law of one price for each duopolistically provided variety, this does not imply factor price equalization – though there is only one factor of production and technologies are the same internationally – since shares in the world market might differ. The optimal production quantity of a monopolist is, as usual, given by (4a) and the factor market clearing condition for country i (8) simplifies to

$$n_m^i x_m^i + n_d s^i x_d = L^i. \quad (8')$$

Given this modified static model, we can now derive welfare implications of the no-growth trap.

¹⁵ The analysis in this section is carried out for the assumption of Cournot-competition. Competition by quantities is, in terms of prices charged compared to prices of a monopolist, a very weak form of competition. Hence, this analysis provides a lower bound. If welfare losses are found here, they would also be found in a situation where competition is fiercer.

Complete two-sided overlap

The example we start with is one of complete two-sided overlap. In such a situation, the advantage of international trade lies entirely "in the future" i.e. is a dynamic rather than a static one. Static gains from trade through expansion of choice of consumption are excluded since only the number of firms but not the amount of different varieties doubles. Dynamic gains could result through a more efficient allocation of labour in the R&D-sector by avoiding duplicative research. This type of gains from trade, however, is not realized since here a combination of fierce and large scale competition stops innovation. What has to be seen is whether the fall of the innovation rate itself leads to a increase or decrease in the welfare level.

In the absence of monopolistic varieties, factor market clearing conditions (8') simplify further to $n_d s^i x_d = L^i$ and total demand (18) is $x_d = E/(n_d p_d)$. This implies, together with the fact that shares add up to unity, that the share of each firm in world demand is given by the relative country size from where it originates,

$$s^i = L^i / L. \quad (20)$$

Since all factors are used for production and no country has any foreign wealth, each firm's output exactly matches domestic demand. An interesting interpretation of such a situation is that – strictly speaking – prices for the final goods equalize not because of trade but because of the threat of trade. If firms behaved as monopolists and increased their prices, competitors abroad would find it profitable to export and hence would increase their output. This, however, would in turn induce domestic firms to increase their output as well, until the Cournot equilibrium is in place again. Hence, the situation an economy ends up here is one in which trade might exist, but net trade flows *in every single market* are zero¹⁶.

We can now study the welfare implications of a no-growth trap. Consumption per variety is given by

$$c_d^i = s^i x_d = \frac{L^i}{n_d}. \quad (21)$$

Gains from trade can then be computed by subtracting the autarky welfare level (11) from the trade welfare level (17), with appropriate consumption levels (12) and (21) inserted. The resulting expression is a function of parameters and the *autarky* innovation rate of the country under consideration. The country enjoys gains from trade if

$$G(g^i) \equiv \alpha \log \left(\frac{L^i}{L^i - g^i} \right) - \frac{1 - \alpha}{\rho} g^i > 0.$$

This equation shows that international trade has two opposing effects on the welfare level of a country. Both effects stem from the shift of employment out of the R&D sector into the production sector. The welfare increasing effect consists in an increasing output of the representative firm, $L^i > L^i - g^i$, hence the first term is positive. The welfare decreasing effect results precisely from the reduction in the growth rate. In order to find out which effect is stronger, observe that there are no gains from trade, if the autarky growth rate was zero, $G(0) = 0$. This is no surprise since in that case trade does not set free factors of production, no reallocation of factors takes place nor are gains caused through a wider choice of variety. If the autarky growth rate is positive, there might be losses or gains from trade, depending on how fast the economy has grown in autarky. Observing that

$$G'(g^i) > 0 \Leftrightarrow g^i > \frac{1}{1 - \alpha} ((1 - \alpha)L^i - \alpha\rho) \equiv g^*$$

and $\lim_{g^i \rightarrow L^i} G(g^i) = \infty$, the gains from trade function can be plotted as in Figure 4.

¹⁶ An alternative interpretation is a reciprocal dumping situation as in Brander and Krugman (1983).

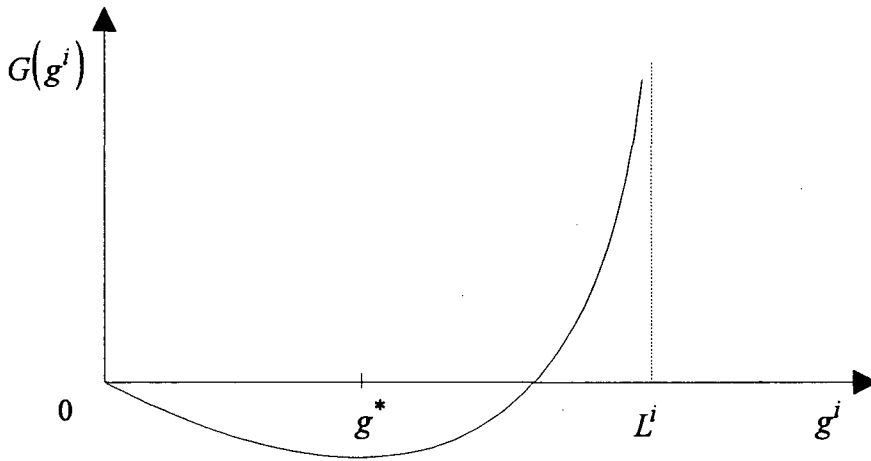


Figure 4: Gains from trade as a function of the autarky growth rate g^i

There is a very intuitive explanation for this shape. Note first that the expression for g^* is the closed economy welfare maximizing growth rate (Grossman and Helpman, 1991, ch. 3.4). This means that there are losses from trade if the autarky innovation rate was below or at its social welfare maximizing value. In that case, dynamic losses through a fall in innovation activities are not compensated for by the static gain in the size of output per variety. The more the autarky growth rate is above its social welfare maximizing value, the smaller are losses from gains since the fall in the innovation rate itself (in addition to the increase in production per variety) is beneficial. The simple reason is that the innovation rate was socially not welfare maximizing and absorbed too many factors. In the extreme case, when all factors in autarky tend to be employed in R&D activities, welfare in autarky was so low due to the inefficiently high innovation rate, that a situation of free trade with no growth is preferred to a closed economy situation with too high trade.

There are no reasons to assume that a closed economy is above its social welfare maximizing innovation rate. Indeed, in the presence of knowledge spillovers between firms it is well known that the decentralized innovation rate falls short of g^* . Hence, this has established that in the case of complete two-sided overlap, there are losses from trade if two countries find itself in a no-growth trap after opening up to trade. Dynamic losses due to the fall in the innovation rate are stronger than static gains resulting from an increase in output per variety.

Complete one-sided overlap and normal overlap

If countries of unequal size begin to trade and they were on a balanced growth path in autarky, equation (10) shows that the number of varieties they export under free trade differs. In such a situation, a complete two-sided overlap is excluded and more general possibilities have to be studied. In order to understand the effects of such asymmetric situations on welfare changes due to international trade, we will first undertake a comparative static analysis of free trade equilibria. In a second step, the equilibria will be compared to the trade equilibrium with complete two-sided overlap. Since we know of the latter that the resulting social welfare level is lower than the one under autarky, we can make statements about the desirability to trade in asymmetric situations.

The two-country world we analyze is completely described by two demand functions (18), four pricing equations (4a) and (19), the share equation for duopolists, $s^A + s^B = 1$, two factor market clearing conditions (8') and the choice of a numeraire. The system is solved numerically by first

solving an equation determining the share of duopolists of country A in the world market as a function of parameters of the model. Then, the remaining variables can be solved directly¹⁷.

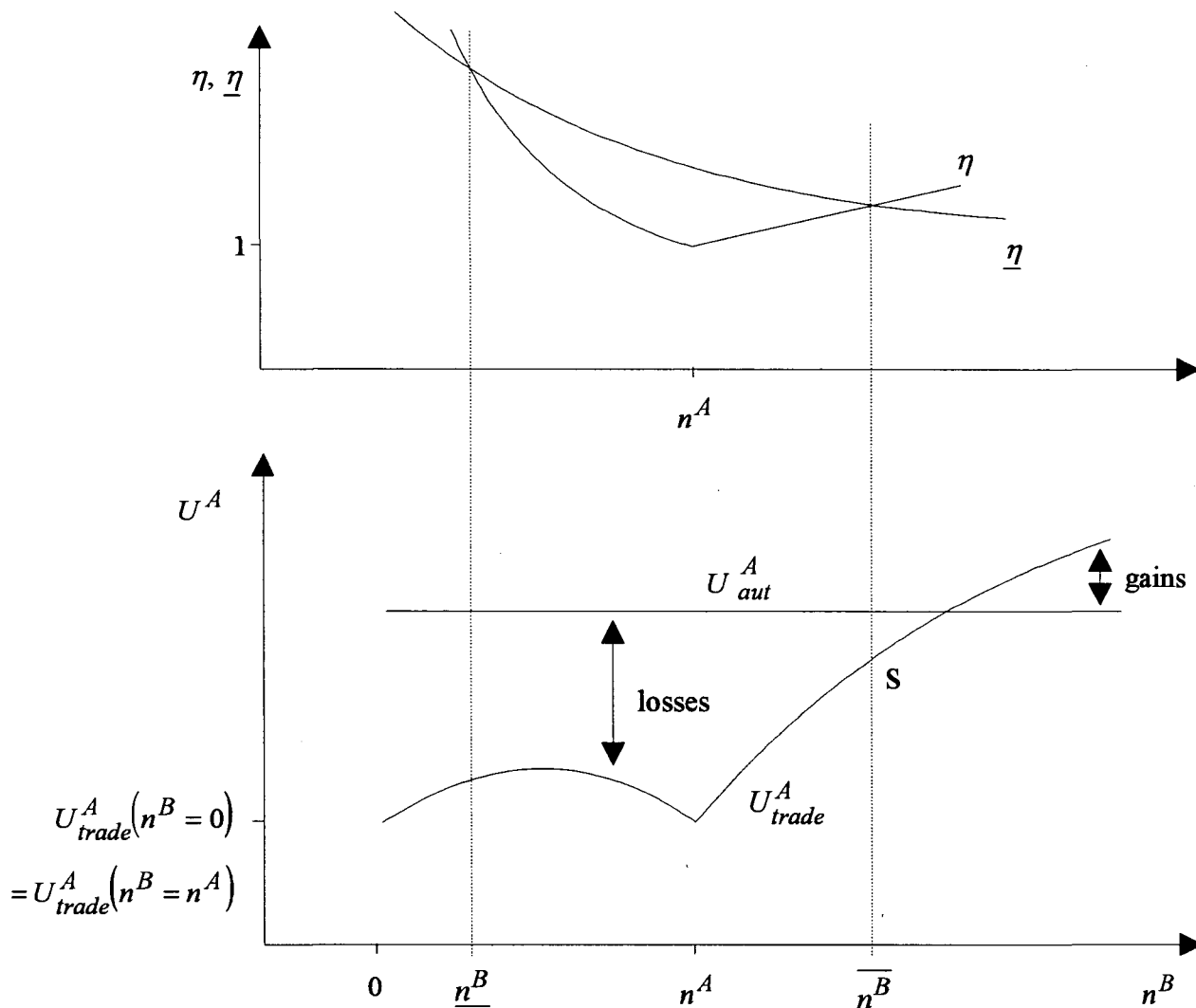


Figure 5: Complete one-sided overlaps

The situation we study as well as the main result are depicted in Figure 5. We assume that the number of varieties in country A at the moment it opens up to trade is given by n^A . We let the number of varieties in country B vary from 0 to some $n^B > n^A$. Remember that by (10) the ratio of number of firms to size of a country is internationally identical in autarky. Hence, this scenario is identical to asking what happens if country A starts to trade with a smaller or larger country¹⁸. Figure 5 reproduces the result of the numerical analysis.

The upper part of Figure 5 shows the range in which the two country world is caught in a no-growth trap. From the analysis of Figure 3 we know that countries do not innovate if $\eta < \underline{\eta}$. By plotting these two variables¹⁹, we obtain the range within which the world is caught in the no-growth

¹⁷ The program (written in Mathematica) including documentation is available from the authors upon request.

¹⁸ The numerical values actually used are $n^A = 50$, $\alpha = .7$, $\rho = .03$, $L^A = .11$, $n^B \in [2, 80]$. L^B is determined by n^B and (10).

¹⁹ When country A starts trading with a smaller country, all varieties of country B are duopolistic, hence $\eta = (n_m + n_d)/n_d$ is given by $\eta = n^A/n^B$. If country A is smaller than country B , η is given by $\eta = n^B/n^A$. The threshold level is computed according to (16), where $\Lambda = .8$ (cf. equ. (5)) has been inserted.

trap²⁰. If $n^B < \underline{n^B}$, country A provides sufficiently enough monopolistic varieties such that the demand shifting effect of duopolistic varieties is not big enough to discourage entry of new firms. If $n^B > \overline{n^B}$, country B provides enough monopolistic varieties to make firm entry profitable.

The lower part of the Figure concentrates on the welfare effects. The welfare level of country A under free trade, U_{trade}^A , as a function of the number of foreign firms n^B has a minimum in the case of complete two-sided overlap $n^B = n^A$. If country A starts to trade with a bigger country, $n^B > n^A$, its welfare level increases compared to the situation of complete two-sided overlap. Obviously, this is caused by the wider choice of varieties at the disposal of consumers in A . If country A starts trading with a smaller country (that is not too small), its welfare level is also higher than in the case of complete two-sided overlap. If the country is half its size gains reach a maximum and then fall again.

Where does this shape come from? Remember that the entire analysis in this section is for a static no-growth trap. If n^B is close to zero, then the factor allocation in country A does not differ between a free trade situation and an autarky situation *with no growth*. In the symmetric case of equal country size and complete two sided overlap, $n^B = n^A$, the factor allocation does not differ, either, between an autarky situation *with no growth* and free trade. In the first case, trade is welfare neutral since n^B is close (equal) to zero and no gains from additional varieties result²¹. In the second case, trade is welfare neutral since all foreign varieties have a domestic counterpart. This establishes that both situations have the same welfare properties for country A , $U_{trade}^A(n^B = 0) = U_{trade}^A(n^B = n^A)$. The reason that there is a maximum (and not a minimum) is that monopolistic firms which export to country B can charge higher prices than do duopolistic firms which export to country A . Therefore, if the number of monopolists increases (starting from zero at $n^A = n^B$), this advantage in terms of market power increases the welfare level. If the other country becomes too small, however, less and less can be traded and the importance of the higher market power of monopolistic firms shrinks. So far the comparative static analysis of trade equilibria.

We now turn to a comparison of free trade with autarky welfare levels. We know from the last subsection that in the case of a complete two-sided overlap, international trade leads to welfare losses, $U_{trade}^A(n^B = n^A) < U_{aut}^A$. If country A starts to trade with a bigger country, the question whether a country enjoys gains from trade depends on which of two effects is stronger: gains through more choice or dynamic losses through a decrease in the growth rate to zero. If country A starts trading with a smaller country, losses from trade are always lower than losses from trade with a country of the same size. The question whether a country always loses in a no-growth trap compared to autarky depends on the autarky utility level. We know from the last subsection (Figure 4) that this benchmark level depends on the autarky innovation rate. The autarky utility level U_{aut}^A (11) plotted here is based on the optimal autarky growth rate for the parameter values given before.

In this case, trade is welfare decreasing for the entire no-growth trap $\left[\underline{n^B}, \overline{n^B} \right]$. Hence, even if a country trades with a country that is not of the same size and a complete two-sided overlap is excluded, there are losses from trade. The same is true if one takes the decentralized autarky growth rate as point of reference; the autarky utility level still lies above the intersection point S . For other parameter values, however, there are decentralized autarky utility levels, that lie below S . This means that there are situations in which free trade with no growth is welfare superior to no trade with growth. This nicely stresses how insufficient it is to look at the growth rate and use it as a welfare indicator.

²⁰ Remember that η is drawn under the assumption that factor prices equalize under free trade (footnote 11). If this assumption does not hold, the derived range slightly shifts. Again, qualitative results remain unchanged.

²¹ In fact, with $n^B = 0$, there is no trade.

The main messages of this analysis are clear. If a country starts trading with a larger country, benefits from trade increase, the larger the other country. A larger country can provide more varieties which reduces the losses from trade. If the country is smaller, there is an optimal overlap. The worst situation is one in which two countries of the same size begin to trade. Since the smaller country always benefits from trade through more varieties and the larger country does not, the latter has a higher incentive to impose impediments to trade than the former. We will shortly see, however, that in the presence of an overlap, it is in the interest of both countries to opt for managed trade liberalization, independent of their size. In the case of a normal overlap, every country gains in welfare through additional varieties that are offered by the foreign country. This means that the curve U_{trade}^A moves upwards and a situation where gains from trade occur would arise earlier, i.e. foreign countries do not have to be much larger in order to make trade beneficial.

Link to static trade theory

One might, justifiably, argue that it is an extreme prediction that opening up to trade condemns economies to a halt of their innovation activities. This is the reason why welfare implications are studied in a dynamic context in the next subsection. The static model, however, is interesting in its own right due to the results it adds to static trade theory. Factor price equalization, one of the central issues in trade theory, is known to hold in static trade models with differentiated goods in the absence of impediments to trade and if countries are not too unequally endowed with factors of production (e.g. Helpman and Krugman, 1985, ch. 7). This finding requires free entry of firms until a zero profit condition for monopolistic firms is satisfied for both countries.

In the present setup, factor prices equalize only if countries are of the same size. Take as easiest example a complete two-sided overlap. Computing relative wages by dividing (19) by itself and inserting (20) gives $w^A/w^B = (\varepsilon L - L^A) / (\varepsilon L - L^B)$. Relative wages depend on relative country size (though we do not have transport costs as Krugman (1980)) simply because with the same number of varieties in each country but different labour endowment, the usually assumed zero-profit condition in static models is not satisfied. We have however shown, that it will not be profitable for firms to undertake further investments (or, better, agents have no incentive to save), hence, though there is free entry in principle, international competition prevents entry of new firms and wages will remain unequal. Since this result generalizes to a situation without a complete two-sided overlap, the assumption of a zero profit condition in static models that causes identical variety per labour ratios turns out to be very restrictive. The example here shows that there are equilibria that are characterized by arbitrary (subject to the restrictions of a no-growth trap) firm to labour ratios that do not lead to factor price equalization.

4.2. Welfare outside the no-growth trap

Following the discussion in the last subsection, the mechanisms increasing or decreasing the prospects of gains from trade should now be clear. On the one hand, static welfare gains and on the other hand, dynamic welfare losses. Obviously, welfare increasing effects are higher, the more new varieties are provided by the foreign country. Welfare losses result from the decrease in the innovation rate though this itself consists of two opposing effects. A welfare decreasing one due to dynamic losses resulting from less innovation and a welfare increasing one due to static gains resulting from higher output per produced variety as a consequence of factors becoming available through the reduction in R&D activity. It has been shown in the last subsection that with a reasonable autarky benchmark case, level gains in output caused by a reduction of employment in R&D are weaker than the innovation losses themselves.

The basic question in the general case of positive innovation under free trade is therefore whether well-understood static gains through more varieties outweigh dynamic losses through less

innovation. The answer to this question can be illustrated with the help of Figure 1. Assume country A has produced $n_m^A + n_d$ varieties prior to t_{trade} . Consumers in this country, when opening up to trade, enjoy an expansion of the range of choice among varieties from $n_m^A + n_d$ to $n_m^B + n_d + n_m^B (\equiv n)$. The question we want to answer is: given an increase in the number of varieties from $n_m^A + n_d$ to n , how big may dynamic losses be such that there are still gains from trade? What is the critical level of the number of duopolistic varieties n_d causing these dynamic losses? Or, equivalently, in terms of Figure 3, how big must η at least be such that there are still gains from trade? The answer to this question can be found numerically only since an analytical evaluation of the utility function over saddle paths starting at different η_0 is not possible. It is easy to provide an existence proof of this value η^* , however. This then establishes that there are gains from trade if and only if $\eta_0 > \eta^*$, i.e. there are gains from trade only if the share of domestic firms that expects direct competitors abroad is not too large.

Set parameter values such that the integrated world economy finds itself in a no-growth trap if (and only if) there is complete two-sided overlap, which means $\underline{\eta} = 1$ in Figure 3 and equation (16). (This can always be achieved by a suitable choice of parameters. An example is $\alpha = .7$, $\rho = .03$, $L = .2$, which implies a growth rate of $g \approx 3.9\%$. The threshold level $\underline{\eta}$ is then unity if $\mu \approx .73$. Since $.73 > .7$, competition in this example is slightly weaker than Bertrand but fiercer than Cournot competition.) It has been shown in the last subsection that the world economy will experience losses from trade in this situation. Now assume that there is no overlap. In that case, there will be no dynamic gains from trade since the growth rate in autarky (9) equals the one under free trade (15). There will be static gains from trade, however, due to the increase in the number of varieties. This says that there are losses for trade for $\eta = 1$ and gains from trade for $\eta = \infty$. Given the monotonicity of the adjustment process, welfare increases from trade are a monotonic function of η , which proves the existence of η^* . Hence, if the scale of competition is too large, given the total number of varieties available for consumption, dynamic losses outweigh static gains and countries loose from trade.

5. A rationale for tariffs?

The last section has provided conditions under which trade equilibria are welfare inferior to autarky equilibria. The question to be answered now is whether these welfare losses are, under the derived conditions, an inevitable consequence of international trade or whether certain coordination measures can increase welfare prospects of trade. This is basically the question whether welfare losses are caused by a market failure that can be corrected for or whether the adjustment process described in the last sections follows an optimal path as in the Heckscher-Ohlin two-sector model with perfect competition (and foresight) and adjustment costs (Mussa, 1978). Put differently, can, in the absence of autarky distortions²², free trade that is characterized by an efficient factor allocation be welfare reducing? This is hard to imagine, apart from the fact that studying the effects of free trade would then be superfluous since countries would no longer trade.

One obvious difference to perfect competition models with no externalities lies in the market structure of the present model. One less obvious but crucial difference lies in the *changing* market structure caused here by international trade. Several aspects are related to this point. On the one hand, the changing market structure leads to more competition, which is generally regarded to be welfare increasing. On the other hand, it changes relative prices between otherwise identical

²² If there are domestic distortions prior to opening up to trade, it is well-known that trade through increasing the effects of the distortion is welfare reducing. Think of Brecher's (1974) example of domestic unemployment due to minimum wages and the effect of a change in terms of trade.

varieties. This leads to a factor allocation which is not welfare maximizing. Finally, the changing market structure leads to lower incentives to innovate. The general question is whether any of these changes is not internalized by the market.

This section will show that it is international trade itself that introduces a distortion and that there are indeed gains from market intervention. It will further be explored to what extent this is a rationale for tariffs²³. A distinction will be drawn between a discriminative tariff applied only to imports of duopolistic varieties and a uniform tariff levied on all imported varieties. All tariffs are ad-valorem and symmetric, i.e. imposed by all countries at the same level.

5.1. The distortions to be corrected for

Why should international trade call for market intervention? Why is central coordination of decisions necessary that can not be optimally taken on a decentralized level? The model presented here gives two reasons: One market failure is caused by a coordination problem between entrepreneurs. This is the well-known distortion due to knowledge spillovers that prevent entrepreneurs to fully appropriate returns to R&D. This effect results in an innovation rate that falls short of the social welfare maximizing one. R&D subsidies would increase the innovation rate up to its social welfare maximizing level (Grossman and Helpman, 1991, ch. 3.4). Since this distortion and how to correct it is well understood and its presence does not influence any of our results, we will not consider it any further. The second one is a coordination problem between consumers. This is the one which is responsible for falling innovation rates and welfare losses as a result of international trade.

International trade leads to higher competition for some firms since some varieties turn out to be very close substitutes. Competition between firms leads to a price differential between otherwise identical monopolistic and duopolistic varieties. Consumers therefore shift their consumption towards duopolistic varieties. It is this shift of demand which causes the distortion to be corrected for. Individuals base their consumption decision on prices of varieties offered and do not take into consideration the related effect this demand shift has on innovation incentives. This neglecting of R&D incentives is an external effect whose consequences can not be cured on a decentralized level. A central planner can correct this distortion by choosing an instrument that corrects relative prices such that R&D incentive effects are taken into consideration.

This discussion has shown that the distortion we are concerned with here results from the effect of opening up to trade on the market structure. This means that the market equilibrium under trade is welfare inferior to a trade equilibrium with market intervention. As a consequence, market intervention is welfare increasing as soon as there is some overlap and not only if the trade welfare level of a country falls below its autarky welfare level.

There are other good reasons to expect that any decrease in the innovation rate due to the overlap leads to welfare losses. A decentralized economy without overlap is characterized by an innovation rate that falls short of the social welfare maximizing innovation rate because of R&D knowledge spillovers. Welfare gains can therefore only be reached if the innovation rate *increases*. Since opening up to trade leads, if anything, to a *decrease* of the innovation rate compared to the long-run (and hence also immediately feasible) world innovation rate g^W (15), this dynamic effect is, ceteris paribus, always welfare decreasing.

Clearly, this does *not* mean that opening up to trade in general is welfare decreasing, this depends on the relative strength of static gains and dynamic losses and, to be strongly emphasized, is not an argument against free trade. It is an argument, however, in favour of managed trade liberalization.

²³ It was one result of the literature on domestic distortions and international trade that trade instruments, such as tariffs are second best policy tools. For a recent short overview, cf. Bhagwati (1994).

5.2. First best instruments

If duopolistic and monopolistic varieties can easily and unambiguously be distinguished, the first best instrument is a discriminative tariff levied on imports of duopolistic varieties only. Given a certain market structure in the duopolistic markets, e.g. Bertrand or Cournot competition, there exists a tariff on imported duopolistic varieties that allows domestic producers to increase their prices up to a level where their markup (4b) equals the one of monopolists (4a)²⁴. A tariff that certainly achieves this is an infinite one since it simply prohibits trade. In such a situation the relative price between monopolistic and duopolistic varieties is unity, $\mu = 1$, as are relative prices between domestic and foreign varieties since the tariff is applied to duopolistic varieties only. The discussion of collusion (which is characterized by $\mu = 1$) above then shows that the integrated world economy immediately jumps to its long-run innovation rate (15). Hence, an economy trapped by too fierce competition due to an overlap gains through tariffs by increasing its growth rate. Discriminative tariffs are welfare increasing because they allow to correct the price distortion between monopolistic and duopolistic varieties. They are permanent since, though the market share of duopolistic varieties decreases over time, duopolistic varieties itself continue to exist.

5.3. A declining tariff as a second best instrument

It can be expected to pose difficulties in the real world to distinguish between monopolistically and duopolistically provided varieties. Elasticities of substitution between close substitutes are not easily observable and the distinction by prices that is theoretically possible may not be a straightforward task in reality. What is usually agreed upon in trade liberalization treaties are trade barriers that are gradually reduced over time but are applied to *all* imports in a given sector. This section will first show that there exists an optimal uniform tariff that is a function of the overlap and, secondly, that this optimal tariff decreases over time. Hence, it rationalizes generally applied trade liberalization schemes.

The first point is proven as follows. If there are only duopolistic varieties, $n_A^m = n_B^m = 0$, competition among duopolists leads to lower profits of potential market entrants than firms would earn if incumbents were monopolists. In such a situation a uniform tariff increases the market power of duopolists vis-à-vis their foreign counterparts. Since more of total demand goes to monopolists that enter the market, the innovation rate and the welfare level rises. If there are monopolistic varieties only, $n_d = 0$, a tariff increases the relative price between domestic and foreign varieties which is a static distortion but has no growth effects²⁵. The static distortion results in a welfare loss as is known from work by Gross (1987). In a situation with some overlap, a tariff has to balance two counteracting effects, the welfare increasing one on the duopolistic side of the market and the welfare decreasing one on the monopolistic side. The fact that there exists an optimal tariff is proven as follows: assume a situation of complete two-sided overlap and assume further that some tariff has been set. This was shown to be welfare increasing. Now allow for some monopolistic varieties by increasing their number by an infinitesimally small amount. If this increase is only small enough, its welfare decreasing effect is smaller than the welfare increasing effect due to the presence of duopolistic varieties. If the share of monopolistic varieties becomes larger, the welfare decreasing effects of a tariff are stronger. Hence, for η not too large²⁶, an optimal tariff exists.

²⁴ Note that the situation here is different from the analysis performed by Brander (1981) and Brander and Krugman (1983). Here, domestic and foreign output decisions are *not* independent due to the link via the ad-valorem tariff between domestic and foreign price.

²⁵ The proof is straightforward for a symmetric world where $L^A = L^B$ and therefore $n^A = n^B$.

²⁶ It can be argued that if η is too large, the welfare decreasing effect is always stronger than the welfare increasing effect. In fact, this can not be ruled out by the argument just given.

The second point can now easily be shown. The above argument establishes that the optimal tariff is a function of the overlap. The bigger the overlap, the more a tariff is beneficial. In a growing world, where the overlap becomes relatively smaller and smaller as new firms enter the market, the beneficial effect of a tariff becomes smaller and smaller. Hence, if the tariff was optimal for a certain overlap as measured by η , the optimal tariff for a smaller overlap must be smaller. Therefore, as long as innovation in the world economy is positive when countries trade with each other and the market share of monopolistic varieties increases over time, optimal trade liberalization requires a tariff that gradually declines over time.

6. Conclusion

The central statement of this paper is that trade theory has so far neglected increasing international competition through changing market structure induced by opening up to trade. Including these aspects allows to provide positive and normative results that give support to policy measures that have been in practice for a long time. The reasons for these measures given here, however, differ from those usually discussed in the public. While the effects on unemployment or restructuring processes are more prominent, price distortions as stressed here, have received much less attention.

Increasing international competition is captured by allowing several firms to produce an identical variety in a model of originally monopolistic competition. This induces a change in relative mark-ups, leading to more consumption and less saving. If trade in goods leads to higher competition, trade decreases the growth rate at the moment countries open up to trade below its long-run balanced growth path value and in some cases even below its autarky value. If these short-run negative effects of free trade are overcome by the trading economies, both countries unambiguously benefit from trade through higher innovation rates in the long run. If competition is too fierce and innovation activity is discouraged too much, free trade implies a welfare loss in the present value sense compared to autarky.

Analyzing the effects of tariffs shows that gradual trade liberalizations as agreed upon in nearly all trade negotiations are highly recommended. Government intervention is beneficial because individual utility maximization takes prices as given and neglects effects of individual demand on profits of incumbents and future market entrants. The reason for trade management lies in the demand shifting power of the government and its ability to internalize this demand externality.

Trade liberalization for more than two countries gives further support to managed trade liberalization. Defining common varieties in such a context as those varieties that are produced by two or more firms, the number of common, "cheap" varieties as a share of the total number of available varieties and therefore the scale of competition are likely to increase with the number of countries. Furthermore, the price of common variety is likely to decrease with the number of suppliers as, e.g., in the case of Cournot competition where the mark-up declines if the market-share falls. Collusion would also become more difficult as coordination among firms becomes harder to achieve, resulting also in a higher probability of competition.

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