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International competition, growth and welfare

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Abstract

Opening up to trade implies a change in market structure as firms are exposed to new competitors. If foreign and domestic firms produce close substitutes, their interaction in the product market forces prices below the monopolistic level. Demand shifts from monopolistic to oligopolistic varieties and incentives to develop new varieties are reduced. The changing market structure constitutes a market failure as competition becomes asymmetric. 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. © 2001 Elsevier Science B.V. All rights reserved.

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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. These fears are fuelled by many issues which have both distributional and efficiency aspects. Many of the transmission channels from

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international trade to the domestic economy have been analysed in the literature. It is the objective of this paper to propose an alternative way of perceiving international competition and an alternative explanation where these concerns may come from.

As an example of the type of competition we have in mind, think of two automobile producers, one in Europe, one in Asia. Each producer designs an automobile for the domestic economy. It does so by choosing the optimal characteristics of this automobile, given the automobiles offered by other domestic competitors. At some point, possibly caused by a free trade agreement, by a reduction of tariffs or by a general reduction in transportation or communication costs, these firms start thinking to export their goods. Once they export, they will find that their choice of characteristics that was optimal for the domestic market is not necessarily optimal for the export market. Some will find that their variety has very close substitutes abroad while others will find that their variety happens to be well-chosen even for the export market. The result of international trade is therefore a change in market structure: While all firms were symmetric monopolistic competitors domestically, when opening up, some firms will experience stronger competition than others and possibly find a direct competitor in their market. This has microeconomic effects not only on e.g. firm profits but also aggregate effects, which constitute the main focus of this paper.

From a modelling perspective, we analyse two growing economies that are initially in autarky. Each country produces many varieties of one final good. We then let countries open up to trade and assume that some varieties that had been developed prior to free trade are identical. Some firms that produced under monopolistic competition in autarky and were the sole supplier of their variety suddenly have to share their market and become duopolists. Other firms remain monopolists in their market. This admittedly strong distinction is a simple way to capture the more general idea that international trade changes the market structure and market power of firms in an asymmetric way.

The impact of international competition as conceived here 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 rate[1] 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, captured by the markup of prices over marginal costs. The change in market structure leads to welfare losses due to an inefficient factor allocation.

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

Welfare losses can be so strong that autarky is preferred to free trade. The first-best corrective device is a discriminatory permanent tariff and second-best devices are non-discriminatory temporary tariffs.

As the present model builds on Grossman and Helpman (1991a), more competition (more firms in a market) unambiguously leads to less innovation as lower profits reduce incentives to innovate. Smulders and van de Klundert (1995), van de Klundert and Smulders (1997), Aghion et al. (1997a) and Aghion et al. (1997b) have presented models where more competition does not necessarily imply lower growth. Smulders and van de Klundert (1995) conclude from their analysis that more competition leads to more innovation if a particular good is provided by few firms, but more competition eventually depresses innovative activity as the number of firms grows large. This inverted U-shape results from an interplay of two innovation increasing effects (public knowledge and monopolisation effect) and two innovation depressing effects (scale and learning-by-watching effect). Aghion et al. (1997a) depart from the assumption of innovative firms as pure profit maximizers and study the effects of managers that incur private benefits from keeping the old technology. Depending on the effect more firms have on net profit flows, more competition can lead to more or less innovation. If competition forces managers to reduce private benefits, more competition implies more growth. Aghion et al. (1997b) study an economy where firms cannot build on existing knowledge and immediately develop superior products but first have to catch-up with the technology leader before being able to develop a superior good. Depending on the interest rate and on how easily firms can imitate, more competition as captured by Bertrand vs. Cournot competition can lead to more or less growth.

Though it would be very interesting to extend the present analysis along these lines, we do not incorporate these more complex approaches here for two reasons: First, we would like to keep the model as simple as possible in order to be able to derive analytical results both for the short-run adjustment process and the long-run equilibrium. Second, more importantly, the central point this paper wants to make does not depend on the effect competition has on innovation. We argue that opening up to trade leads to a distortion in goods markets which gradually vanishes over time[2] in a free-market setup and can be internalized immediately by appropriate policy measures. This distortion is, assuming the absence of second-best world effects, welfare reducing, independently on more or less growth due to competition.[3]

[2] If reallocation of varieties could take place at no cost, no distortion would arise. Costless reallocation does not seem to be a realistic assumption, however.

[3] The present paper can be seen in the spirit of Baldwin and Forslid (1998), who argue in favour of more complex trade and growth models that allow to better understand links between international competition and growth.

The paper complements findings on gains from trade by stressing that distortions introduced by opening up to trade (in contrast to distortions that pre-existed trade as e.g. in Brecher (1974)) can lead to welfare losses. It also shows how crucially findings of the new growth theory (Grossman and Helpman, 1991a; Rivera-Batiz and Romer, 1991) that countries experience an increase in their growth rates as they open up (cf. however Stokey, 1991) depend on a long-run (and potentially misleading) perspective. In the present paper, 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 an economy's growth rate can fall even permanently.[4]

2. The model

There are two countries that have access to identical technologies and share common preferences. Before opening up to trade, each country has already produced a certain range of varieties. Opening up to trade comes as a surprise to monopolistic producers and some will therefore find a foreign competitor in their own market. Hence, we study a two-country model similar to Grossman and Helpman (1991a, Chapter 9). In contrast to them, however, international trade implies that some varieties are produced by both a domestic and a foreign firm.

2.1. The basic trade model

Utility of a consumer living in country i ($i = \mathrm{A}, \mathrm{B}$) at time t stems from a stream of future consumption, discounted at the time preference rate ρ, and is given by

$$U^i(t) = \int_t^\infty \exp[-\rho(\tau - t)] \ln C^i(\tau)\,\mathrm{d}\tau. \tag{1}$$

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

[4] From a technical perspective, the present paper analyses adjustment processes as e.g. Dellas and de Vries (1995). 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).

$C^i(\tau) = (\int_0^n x(k)^\alpha \, dk)^{1/\alpha}$, $0 < \alpha < 1$. With perfect capital markets, a world wide identical interest rate $r(t)$ leads to growth of expenditure E^i that is the same for all consumers,

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

Denote by n_m the number of monopolistically provided and by n_d the number of duopolistically provided varieties, by p_j, $j = \mathrm{m}, \mathrm{d}$, the price of these varieties and by $\varepsilon = 1/(1-\alpha) > 1$ the demand elasticity. In an equilibrium with factor price equalization, total demand for a variety is given by

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

Varieties k are produced under constant returns to scale using labour L_k as input, $x(k) = L_k$. All monopolistic varieties are priced at

$$p_m = w/\alpha, \tag{4a}$$

where w is the wage rate. Since the outcome of the model implies factor price equalization (cf. below), 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

$$p_d = Mw, \tag{4b}$$

where M 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

$$\dot{n}_m^i = L_R^i K_n, \tag{5}$$

where K_n is the international stock of knowledge and L_R^i is the quantity of labour allocated to R&D in country i. 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,

$$v_m = c_R^i = w/K_n. \tag{6}$$

The equilibrium value v_{m} of such an innovation equals the discounted sum of its future profits,

$$v_{\mathrm{m}}(t) = \int_t^{\infty} \exp\left[-(R(\tau) - R(t))\right]\pi_{\mathrm{m}}(\tau)\,\mathrm{d}\tau, \tag{7}$$

where profits are $\pi_{\mathrm{m}}(\tau) = (1-\alpha)p_{\mathrm{m}}x_{\mathrm{m}}$ and $R(u) = \int_0^u r(s)\,\mathrm{d}s$. This equation holds exactly when countries trade with each other, which is the situation we study. Under trade, each newly created firm will remain a monopolist forever. In autarky, this equation only gives the *perceived* value of a new firm. It is not the actual value as some of the firms that produce as monopolist under autarky become duopolistic firms under trade. This is a reasonable specification given our assumption that trade comes in an unexpected manner.

Full employment for labour requires that demand of the R&D sector and of the production process of monopolistic and duopolistic varieties equals 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

$$L_{\mathrm{R}}^i + L_{\mathrm{m}}^i + L_{\mathrm{d}}^i = \frac{\dot{n}_{\mathrm{m}}^i}{K_n} + n_{\mathrm{m}}^i x_{\mathrm{m}}^i + n_{\mathrm{d}} s^i x_{\mathrm{d}} = L^i. \tag{8}$$

2.2. The autarky benchmark case

This section derives an autarky point of reference for comparison of growth and welfare effects. 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. As the scope is to determine the effect of international competition through trade in goods, the ideal benchmark case would 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 already in autarky.[5] Unfortunately, the present setup does not allow a distinction of consumption smoothing effects from competition effects. Since the former are welfare increasing, however, potential welfare losses through trade found later are even stronger, if consumption smoothing was not allowed for.

[5] This does not ignore neither question empirical results as e.g. Coe et al. (1997) or 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 is entirely analytically motivated 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.

Allowing for autarky knowledge spillovers leads to an innovation rate in autarky that exceeds its counterpart of a closed economy with no spillovers by $L^i K_n / L(n^A + n^B)$. 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 and 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 (cf. Appendix B)

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

An economy's autarky welfare level can be 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,

$$U_{\text{aut.}}^i = \frac{1}{\alpha\rho}\left(\ln(n_0^i) + \alpha \ln(x_0^i) + \frac{1-\alpha}{\rho} g^i\right). \tag{10}$$

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

$$x_0^i = (L^i - g^i)/n_0^i. \tag{11}$$

2.3. *Reduced form of the integrated world economy*

The model predicts factor price equalization as long as innovative activity is profitable in both countries. Since countries produce with identical technologies both in the production and in the R&D process (where for the latter international knowledge spillovers are crucial), 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 in A would have to be compensated for 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. (A formal proof[6] would follow the lines in Wälde (1996).)

Understanding welfare and growth effects of international trade requires an understanding of the integrated world economy. It can be easily 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, $\eta \equiv (n_{\mathrm{m}} + n_{\mathrm{d}})/n_{\mathrm{d}} = n/n_{\mathrm{d}}$. The other one is the ratio of nominal world expenditure to the wage rate, $\delta \equiv E/w = E/(nv_{\mathrm{m}})$. Letting further μ denote the relative price between a monopolistic and a duopolistic variety (4), $\mu \equiv p_{\mathrm{d}}/p_{\mathrm{m}}$, the system reads (cf. Appendix A), given factor price equalization,

$$\frac{\dot{\eta}(t)}{\eta(t)} = L - \alpha\left(1 + \frac{\mu^{-\varepsilon}(1-\mu)}{\eta(t) + \mu^{1-\varepsilon} - 1}\right)\delta(t), \tag{12}$$

$$\frac{\dot{\delta}(t)}{\delta(t)} = \begin{cases} \delta(t)\left(1 + \dfrac{1 - \mu^{1-\varepsilon} - \alpha(1-\mu^{-\varepsilon})}{\eta(t) + \mu^{1-\varepsilon} - 1}\right) - \rho - L & \text{if } \dot{\eta} > 0, \\ \dfrac{(1-\alpha)\eta}{\eta + \mu^{1-\varepsilon} - 1}\delta - \rho & \text{if } \dot{\eta} = 0. \end{cases} \tag{13}$$

Given the fact that no copying of already existing varieties will take place once countries have opened up to trade, the share η^{-1} of duopolistically provided varieties in the number of all varieties continuously declines and will eventually become negligibly small. In the long-run, defined by η approaching infinity, (12) and (13) show that the constant innovation rate is

$$g^{w} = (1-\alpha)L - \alpha\rho. \tag{14}$$

3. International competition and growth

International competition is a two-dimensional phenomenon. The *scale* of competition is a consequence of the changing market structure scenario. It is the higher, the higher the initial overlap n_{d}/n $(= \eta^{-1})$ and falls as η rises. The *intensity* of competition within a market will be captured by the price ratio of monopolistically to duopolistically supplied varieties, $\mu = p_{\mathrm{d}}/p_{\mathrm{m}}$. Fiercer competition implies a lower price p_{d} of a duopolistic variety and a lower price ratio μ (see Table 1)

As Table 1 shows, prices of duopolistic varieties equal the wage rate under Bertrand competition. Hence, the mark-up is unity and the price ratio equals the

[6] Such a proof is in our earlier Discussion Paper version (Tang and Wälde, 1998).

Table 1
Competitive behaviour, associated markups and intensity of competition

Competitive behaviour	Markup M	Price ratio $\mu = \alpha M$
Bertrand	1	α
Cournot	$2(1+\alpha)^{-1}$	$2\alpha(1+\alpha)^{-1}$
Collusion	α^{-1}	1

inverse of the markup of monopolists. Under Cournot-competition,[7] the price of a duopolistic variety is higher than the Bertrand price but lower than a price charged by a monopolist.[8] 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, $\alpha \leqslant \mu \leqslant 1$.

With a fixed relative price of $\mu < 1$, the evolution of the integrated world economy in terms of the auxiliary variables as used in (12) and (13) can be illustrated with the help of Fig. 1.

The horizontal axis shows the ratio of different varieties in the world as a whole to the number of duopolistically provided varieties, $\eta = n/n_{\mathrm{d}}$. It ranges from 1 to ∞. The vertical axis plots $\delta = E/E(nv_{\mathrm{m}})$. 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,

$$\underline{\eta} = (\mu^{-\varepsilon} - 1)\,\frac{\alpha\rho}{(1-\alpha)L - \alpha\rho}, \tag{15}$$

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 ($\eta < \underline{\eta} \Leftrightarrow n_{\mathrm{m}} < (\underline{\eta} - 1)n_{\mathrm{d}}$), innovation in both countries comes to a halt: as the phase diagram shows, there is no trajectory for $\eta < \underline{\eta}$ that leads to a long-run equilibrium. The economy would immediately settle on the zero-motion line for δ.

Keeping the scale of competition fixed, the probability that two countries are caught in such a trap depends on a variety of influences that are visible in

[7] The distinction between Cournot and Bertrand competition to capture the intensity of competition was also used e.g. by van de Klundert and Smulders (1997) and Aghion et al. (1997b).

[8] 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.

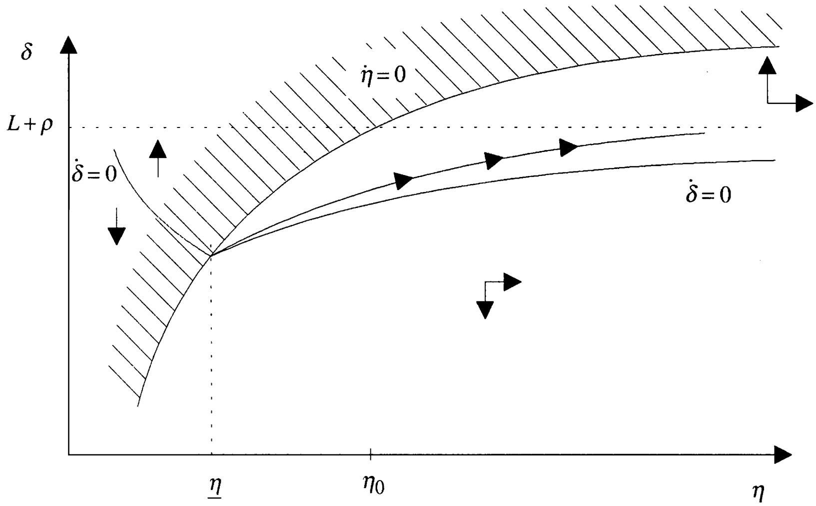

Fig. 1. The integrated world economy.

Eq. (15). The most important one is the intensity of competition between foreign and domestic firms in the duopolistic market as captured by 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 (15), 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 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.[9]

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.

[9] The possibility of a no-growth trap stresses the importance of studying adjustment processes; balanced growth paths, that are usually analysed, might actually never arise.

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 scale of competition is not too large, $\eta_0 > \underline{\eta}$, the introduction of new products paves the way for further innovation. 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 (14) in the long run.

4. International competition and welfare

Do falling innovation rates due to international competition imply that a country is worse off under trade than in autarky? The present model allows for a rich variety of results. Due to space constraints, we formally present only a simple example that shows why opening up to trade can be welfare inferior to autarky.[10] An informal discussion will then discuss welfare effects of more complex situations. Generally speaking, trade is welfare inferior to autarky if dynamic losses from a reduction in the innovation rate are larger than static gains from increases in consumption per variety and increases in the number of varieties available for consumption.

4.1. The no growth trap with complete overlap

We focus on a no-growth trap with complete overlap, i.e. each domestic firm has one foreign competitor and vice versa. In such a situation, the advantage of

[10] For a more detailed analysis, see our discussion paper version (Tang and Wälde, 1998).

international trade lies entirely 'in the future', i.e. 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 intense and large scale competition stops innovation. What therefore 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 and with no innovation, factor market clearing conditions (8) simplify to $n_d s^i x_d = L^i$ and total demand (3) 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,

$$s^i = L^i/L. \tag{16}$$

Consumption per variety is given by

$$c_d^i = s^i x_d = \frac{L^i}{n_d}. \tag{17}$$

Gains from trade can be computed by subtracting the autarky welfare level (10) from the trade welfare level. The latter can be computed in analogy to (10) only that the growth term is missing,

$$U_{\text{trade}}^i = \frac{1}{\rho\alpha} \ln (n_d (c_d^i)^\alpha).$$

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

$$G(g^i) \equiv \alpha \ln \left(\frac{L^i}{L^i - g^i} \right) - \frac{1-\alpha}{\rho} g^i > 0. \tag{18}$$

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, $L^i > L^i - g^i$. The welfare decreasing effect results from the reduction in the growth rate. There are no gains from trade if the autarky growth rate has been 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 varieties. If the autarky

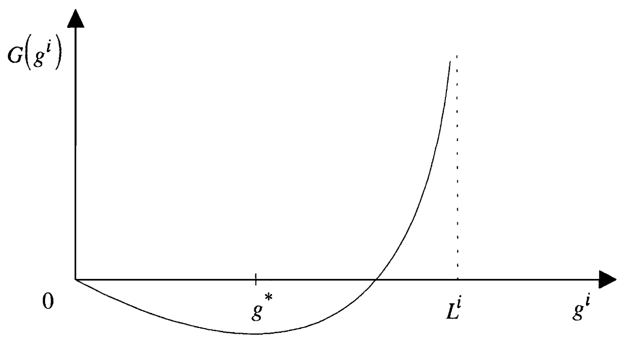

Fig. 2. Gains from trade as a function of the autarky growth rate g^i.

growth rate is positive, there might be losses or gains from trade, depending on how fast the economy has grown in autarky. Observing that (cf. Appendix B)

$$G'(g^i) > 0 \Leftrightarrow g^i > \frac{1}{1-\alpha}((1-\alpha)L^i - \alpha\rho) \equiv g^* \tag{19}$$

and $\lim_{g^i \to L^i} G(g^i) = \infty$, the gains from trade function can be plotted as in Fig. 2.

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, 1991a, Chapter 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 trade since the fall in the innovation rate itself (in addition to the increase in production per variety) is beneficial as R&D 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 growth.

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, in the case of a complete two-sided overlap, there are losses from trade if two countries find itself in a no-growth trap. Dynamic losses due to the fall in the innovation rate are stronger than static gains resulting from an increase in output per variety.

4.2. More general cases

Let us now assume that country A starts trading with a larger economy but both economies are still in the no-growth trap after opening up. Obviously, a complete overlap is no longer possible and the country gains through additional varieties provided from abroad. The country also gains compared to the situation of a complete overlap when it trades with a smaller partner. The country can then extract rents from this country when trading varieties for which it holds a monopoly. These gains through more varieties or monopoly rents compensate losses from trade due to the stop in innovation activity but, for plausible parameter values, do not overcompensate dynamic losses.

When we turn to dynamic aspects, the basic mechanisms should be clear. On the one hand, static welfare gains, on the other hand, dynamic welfare losses. It can be easily seen that in a growing integrated world there is a critical overlap η^* below which a country loses from trade and above which it gains from trade. Assume the country loses in the no growth trap $\eta = \underline{\eta}$ which the last section has shown to be a plausible outcome. We know that a country gains for $\eta \to \infty$ as this implies no overlap, no reduction in the growth rate but a gain through foreign varieties. It is then clear that there exists a threshold level $\underline{\eta} < \eta^* < \infty$ where autarky welfare and trade welfare levels are the same. 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 lose from trade.

5. A rationale for tariffs?

The model predicts two market failures. One is the well-known coordination problem due to knowledge spillovers that prevent entrepreneurs to fully appropriate returns to R&D. This effect results in too low innovation rates and R&D subsidies would be required (Grossman and Helpman, 1991a, Chapter 3.4). The second one is a coordination problem between consumers which results from the effect trade has on the market structure. It causes falling innovation rates and welfare losses. Clearly, correction of market failures is desirable independently of whether the country loses compared to autarky or not. As there are two market failures, we propose two instruments to correct them. One instrument is the standard R&D subsidy to correct the knowledge-spillover distortion. We assume that appropriate R&D subsidies are paid in each country.[11] The second one are tariffs that correct relative prices and eliminate demand distortions. Which form the second instrument can take is the subject of this section.

[11] The following arguments would not change if R&D subsidies were not paid.

The second market failure is a consequence of international trade. Trade leads to higher competition for some firms since some foreign varieties turn out to be very close substitutes. This leads to a price differential between otherwise identical monopolistic and duopolistic varieties and consumers shift consumption towards duopolistic varieties. Individuals do not take into consideration the effect this demand shift has on innovation incentives. This neglecting of R&D incentives is an external effect which a central planner can internalize. The consequence of the second market failure is a market equilibrium under trade that is welfare inferior to a trade equilibrium with market intervention. As was shown, welfare under the market equilibrium can even lie below autarky welfare. Independently of the question whether losses from trade as compared to autarky occur (depending on the relative strength of static gains and dynamic losses), welfare gains can be achieved by reducing these distortions.

5.1. 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).[12] With an infinite tariff that prohibits trade, the relative price between monopolistic and duopolistic varieties is unity, $\mu = 1$, as are relative prices between domestic and foreign varieties. With $\mu = 1$, (12) and (13) show that the integrated world economy immediately jumps to its long-run innovation rate (14). Hence, an economy trapped by too fierce competition due to an overlap gains through tariffs. Discriminative tariffs are welfare increasing because they allow to correct the price distortion between monopolistic and duopolistic varieties. They should be permanent since duopolistic varieties will continue to be produced. Protection of the economy as a whole is declining, however, since the market share of duopolistic varieties decreases over time.

5.2. A declining tariff as a second best instrument

It might pose difficulties to always correctly distinguish between monopolistically and duopolistically provided varieties. Elasticities of substitution between

[12] 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.

close substitutes are not easily observable and the distinction by prices that is theoretically possible may not be a straightforward task in reality. This section therefore discusses the effects of a gradually decreasing tariff which is applied to *all* imports. It will first be shown that there exists an optimal uniform tariff that is a function of the overlap and, secondly, that this optimal tariff decreases over time.

The first point can be seen as follows. If there are only duopolistic varieties, 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, a tariff increases the relative price between domestic and foreign varieties which is a static distortion but has no growth effects. (The proof is straightforward for a symmetric world where $L^{\mathrm{A}} = L^{\mathrm{B}}$ and therefore $n^{\mathrm{A}} = n^{\mathrm{B}}$.) 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 these two counteracting effects: the welfare increasing one on the duopolistic side of the market and the welfare decreasing one on the monopolistic side.

Assume a situation of complete 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 sufficiently small, 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 large,[13] an optimal tariff exists.

This 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 shrinks as new firms enter the market, the beneficial effect of a tariff falls. 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.[14]

[13] 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 cannot be ruled out by the argument just given.

[14] One could further inquire how an optimal R&D subsidy changes over time. One should expect that the R&D subsidy approaches its first best value when the optimal tariff approaches zero. We are grateful to the referee for pointing this out to us.

6. Conclusion

Opening up to trade changes and the market structure increases international competition. 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, at the moment countries open up to trade, trade in goods leads to higher competition, trade lowers the growth rate 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 liberalization can be welfare improving. 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 is welfare inferior to autarky if R&D incentives are reduced too much through decreasing prices. There are gains from trade if trade liberalization is accompanied by appropriate liberalization schemes.

The basic trade-offs would remain the same if the economy was characterised by continuous quality upgrading (Grossman and Helpman, 1991b). In these models, the industry leader charges a Bertrand price such that the follower is just driven out of the market. Letting two countries trade with each other, some industries will be characterized by two firms that offer goods of an identical quality whereas in other industries the quality of one firm dominates. In industries where two firms offer the same quality price competition leads to an equalization of prices to marginal costs. Hence, prices in industries with duopolists are lower than prices in industries where there is a quality leader. This leads again to the same shift in demand and reduction in incentives to innovate as analysed above.

Firms do not have to form myopic expectations for the effects to be relevant. If firms could *at no cost* observe variants produced by all firms in all potential trading countries, an overlap would not exist. But such an assumption would be unrealistic. Given costly information acquisition, firms could assign ex ante positive probability to having a competitor in their own market at some future date T. Still, opening up to trade would reveal new information and some markets will be more competitive than others.

If firms found imitation of domestic varieties profitable in autarky such that there are several firms in each market of the autarky economy, an autarky equilibrium would be symmetric. Again, international trade would lead to an asymmetric situation where some markets have more competitors than others due to this rationally incomplete anticipation of future additional competitors in a certain market.

All that matters for our basic mechanism to be relevant is a symmetric autarky equilibrium and an asymmetric market structure after opening up to trade. Opening up to trade partly changes the domestic (and foreign) market structure. Some firms will experience more product market competition from abroad than others. This leads to price differentials between otherwise identical goods. The implied distortion is welfare reducing and only gradually vanishes over time.

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Appendix A. The reduced form of the world economy

Eq. (12) is found by inserting (8) into $\dot{\eta}/\eta = \dot{n}_{\mathrm{m}}/K_n = \dot{n}^{\mathrm{A}}_{\mathrm{m}}/K_n + \dot{n}^{\mathrm{B}}_{\mathrm{m}}/K_n$. To this end, rearrange (8) to $\dot{n}^i_{\mathrm{m}}/K_n = L^i - n^i_{\mathrm{m}} x^i_{\mathrm{m}} - n_{\mathrm{d}} s^i x_{\mathrm{d}}$ and obtain $\dot{\eta}/\eta = L - n^{\mathrm{A}}_{\mathrm{m}} x^{\mathrm{A}}_{\mathrm{m}} - n^{\mathrm{B}}_{\mathrm{m}} x^{\mathrm{B}}_{\mathrm{m}} - n_{\mathrm{d}} x_{\mathrm{d}}$. Observing that demand for monopolistic varieties is the same independently of their origin (as prices are identical which in turn results from factor price equalization), inserting demand functions (3) yields

$$\begin{aligned}
\frac{\dot{\eta}}{\eta} &= L - n_{\mathrm{m}} \frac{p_{\mathrm{m}}^{-\varepsilon}}{n_{\mathrm{m}} p_{\mathrm{m}}^{1-\varepsilon} + n_{\mathrm{d}} p_{\mathrm{d}}^{1-\varepsilon}} E - n_{\mathrm{d}} \frac{p_{\mathrm{d}}^{-\varepsilon}}{n_{\mathrm{m}} p_{\mathrm{m}}^{1-\varepsilon} + n_{\mathrm{d}} p_{\mathrm{d}}^{1-\varepsilon}} E \\
&= L - \frac{n_{\mathrm{m}} p_{\mathrm{m}}^{-\varepsilon} + n_{\mathrm{d}} p_{\mathrm{d}}^{-\varepsilon}}{n_{\mathrm{m}} p_{\mathrm{m}}^{1-\varepsilon} + n_{\mathrm{d}} p_{\mathrm{d}}^{1-\varepsilon}} E \\
&= L - \frac{n_{\mathrm{m}} p_{\mathrm{m}}^{1-\varepsilon} + n_{\mathrm{d}} \mu^{-\varepsilon} p_{\mathrm{m}}^{1-\varepsilon}}{n_{\mathrm{m}} p_{\mathrm{m}}^{1-\varepsilon} + n_{\mathrm{d}} p_{\mathrm{d}}^{1-\varepsilon}} \frac{E}{p_{\mathrm{m}}} = L - \frac{n_{\mathrm{m}} + n_{\mathrm{d}} \mu^{-\varepsilon}}{n_{\mathrm{m}} + n_{\mathrm{d}} \mu^{1-\varepsilon}} \alpha \frac{E}{w},
\end{aligned}$$

where the last but one equality used $p_d = \mu p_m$. As $\alpha E w^{-1} = \alpha\delta$ and

$$\frac{n_m + n_d\mu^{-\varepsilon}}{n_m + n_d\mu^{1-\varepsilon}} = \frac{n_m + n_d + n_d\mu^{-\varepsilon} - n_d}{n_m + n_d + n_d\mu^{1-\varepsilon} - n_d} = \frac{\eta + \mu^{-\varepsilon} - 1}{\eta + \mu^{1-\varepsilon} - 1}$$

$$= \frac{\eta + \mu^{-\varepsilon} - 1 + \mu^{1-\varepsilon} - \mu^{1-\varepsilon}}{\eta + \mu^{1-\varepsilon} - 1} = 1 + \frac{\mu^{-\varepsilon} - \mu^{1-\varepsilon}}{\eta + \mu^{1-\varepsilon} - 1},$$

we obtain (12).

Eq. (13) can be obtained by differentiating (7) with respect to time, $\pi_m + \dot{v}_m = r v_m$, and inserting this with the expenditure equation (2) into $\dot{\delta}/\delta = \dot{E}/E - \dot{n}/n - \dot{v}_m/v_m = -\rho - \dot{\eta}/\eta + \pi_m/v_m$, where $\dot{n}/n = \dot{\eta}/\eta$ has been used. The profit ratio can be written as

$$\frac{\pi_m}{v_m} = (1-\alpha)\frac{p_m x_m}{v_m} = (1-\alpha)\frac{p_m^{1-\varepsilon}}{n_m p_m^{1-\varepsilon} + n_d p_d^{1-\varepsilon}}\frac{E}{v_m} = \frac{(1-\alpha)(n_m + n_d)}{n_m + n_d\mu^{1-\varepsilon}}\delta$$

$$= \frac{(1-\alpha)(n_m + n_d)}{n_m + n_d + n_d\mu^{1-\varepsilon} - n_d}\delta = \frac{(1-\alpha)\eta}{\eta + \mu^{1-\varepsilon} - 1}\delta$$

and inserting gives

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

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

As

$$\alpha + \frac{\alpha\mu^{-\varepsilon}(1-\mu) + (1-\alpha)\eta}{\eta + \mu^{1-\varepsilon} - 1} = \frac{\alpha(\eta + \mu^{1-\varepsilon} - 1) + \alpha\mu^{-\varepsilon} - \alpha\mu^{1-\varepsilon} + (1-\alpha)\eta}{\eta + \mu^{1-\varepsilon} - 1}$$

$$= \frac{-\alpha + \alpha\mu^{-\varepsilon} + \eta}{\eta + \mu^{1-\varepsilon} - 1}$$

$$= \frac{-\alpha(1 - \mu^{-\varepsilon}) + \eta + \mu^{1-\varepsilon} - 1 - \mu^{1-\varepsilon} + 1}{\eta + \mu^{1-\varepsilon} - 1}$$

$$= 1 + \frac{1 - \mu^{1-\varepsilon} - \alpha(1 - \mu^{-\varepsilon})}{\eta + \mu^{1-\varepsilon} - 1},$$

we obtain (13).

When $\eta < \underline{\eta}$ in the no-growth trap and therefore $\dot{\eta} = 0$, we obtain

$$\dot{\delta}/\delta = -\rho + \pi_{\mathrm{m}}/v_{\mathrm{m}} = \frac{(1-\alpha)\eta}{\eta + \mu^{1-\varepsilon} - 1}\delta - \rho.$$

Appendix B. Further derivations

A more detailed appendix is available at http://www.waelde.com/publications.html

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