Essays on Economic Growth and Imperfect Markets

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4 INTERNATIONAL COMPETITION, GROWTH AND WELFARE: THE CASE FOR MANAGED TRADE LIBERALISATION

4.1 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 Eastern European countries are under way.

Economists, on the other hand, emphasize gains from international trade. The traditional argument is that gains derive from better specialization according to comparative advantages. More recent approaches have put forward different arguments as well. For example, Krugman (1979, 1981) shows that removing barriers to trade expands the range of products available to consumers and producers and forces producers to better exploit economies of scale. Besides, trade of goods and services may promote the international transfer of technology and knowledge and improve the dynamic performance of economies. Grossman and Helpman (1990, 1991) as well as Rivera-Batiz and Romer (1991) combine relatively recent contributions to growth and trade theory to show that by increasing the scope or the pace of technological spillovers trade boosts economic growth. Grossman and Helpman also mention that trade avoids wasting resources employed in redundant, duplicative research.

These and other arguments form a solid defence of the case for free trade. However, other considerations than the gains that trade may bring, matter as well. Such a consideration is for example the distribution of the gains. The prospect of future gains is not the main reason behind the debate about globalisation and its consequences. Rather the distribution of the gains draws most of the attention. For example, many fear that low-skilled workers will lose and at least that income inequality will rise. Another consideration is timing of the gains. The whole idea behind trade liberalisation is to restructure economies. Restructuring is essential for delivering gains, but may also impose cost. Trade liberalisation is best seen as an investment. The gains are in the future, but the costs are incurred in the present. This may give rise to another distributional conflict. The possibility is real that later, unborn generations benefit, but that current generations lose.

The notion that the short-run and long-run effects of trade liberalisation are different and perhaps very different, is not revolutionary. Mussa (1978), for example, incorporates adjustment costs in the Heckscher-Ohlin model and explicitly studies the dynamics of trade liberalisation. However, the more recent approaches to international trade, assuming monopolistic competition and increasing returns to scale, have largely ignored transitional dynamics so far. Most ideas have been put forward by developing static models, and studies into the dynamic effects of trade have mainly concentrated on balanced-growth paths. This chapter studies short-run effects of trade liberalisation. It supplements earlier work by Krugman, Helpman and many others, that has focused on long-run effects. Studying the short run qualifies the by now traditional argument that international trade expands the range of available products and is therefore beneficial. This chapter shows that this much depends on the pace of trade liberalization.

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 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 captures the idea of increased competition due to international trade.

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 important, the expected return on investment in the development of a new variety. These lower R&D returns imply a lower innovation rate 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 temporary tariffs.

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.

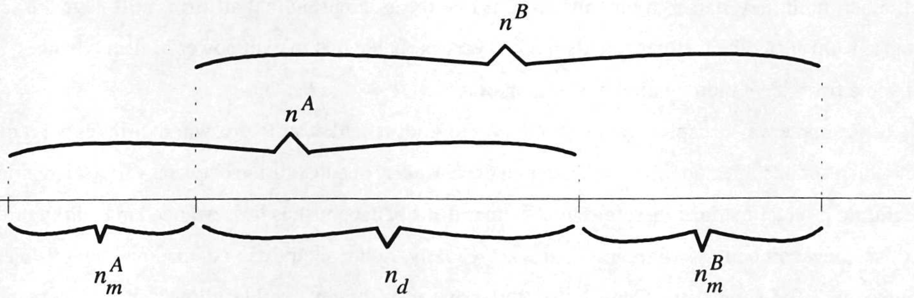
4.2 The model

This section is subdivided into three parts. The first is the starting point of the chapter and in particular introduces a concept for international competition. The second part 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.

4.2.1 *Overlap of varieties*

The model distinguishes 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 difference is the concept of international competition, illustrated in Figure 4.1.

Figure 4.1 *Overlap of varieties*



Before opening up to trade, each country already produces a certain range of varieties. As shown in Figure 4.1, $n^A = n_m^A + n_d$ 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 analysed in trade models. One argument for analysing this situation only is that market entrants do not have the incentive 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 developed[24]. A second, usually not explicitly spelled out, argument is that only long-run economic effects of international trade are studied. Any adjustment process that might set in after allowing for international trade can therefore be neglected.

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. Opening up reveals that some or even all varieties produced at home are close substitutes for those that have been developed abroad. This changes the market structure.

The chapter accepts the standard assumption that the elasticity of substitution between goods is identical for all pairs of firms only for a country in autarky. This assumption about substitution elasticities can be understood as a formalization of the idea that new market entrants know the location of products offered by incumbents and place their product optimally. Under complete information, all goods are equally imperfect substitutes for each other. Letting two countries evolve independently of each other, until they start to trade, makes clear that the assumption that all firms still have the same distance from each other is then unrealistic. It is very probable that market power of firms changes, and that some firms have more market power than others.

A simple way to capture this asymmetry is to study a market structure, where firms either remain monopolists or become duopolists and keeping the elasticity of substitution between varieties invariant. Integrating product markets therefore implies that firms behave just as they behaved in autarky or that they face new competitors on their own market. Clearly, richer setups can be imagined but this one is adopted here for simplicity. Considering this possibility of an overlap allows to give a realistic interpretation of concerns about welfare and growth reducing effects of a sudden, rapid trade liberalization.

One might argue that such an overlap could not arise. 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 cannot be assumed at all times. Not all policy decisions can be anticipated.

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

Besides, and more important, in autarky *imitation* of varieties produced abroad may be profitable. The standard argument that imitation of domestic varieties does not occur, because sharing a market is less profitable than owning one, does not apply to imitation of foreign varieties in the presence of high trade barriers. These aspects – imperfect information and imitation – appear realistic and intuitively clear, and we therefore did not explicitly model them.

The question then remains why firms do not relocate their products on the goods market to restore their market power once an overlap is revealed. Clearly, this would happen if relocation was costless. Allowing for costly relocation would then raise the question whether investment in relocation yields higher returns than investment in other forms, for example the development of completely new varieties. If these costs are not substantially lower than costs of R&D, investors would not finance relocation: The increase in profits earned from relocation equals the difference between profits from a monopoly and profits from duopolistic competition. If the latter are different from zero or if relocation costs equal R&D costs, investment in a new variety is always more profitable than relocation. Hence, no relocation activities would take place.

The main motivation for allowing for an overlap of varieties is that we do not take a long-run approach to studying economic phenomena. In the long-run, it is reasonable to assume that all firms chose an optimal distance from each other and that they therefore all behave identically. Hence, we do not question this standard assumption in static models, neither in dynamic models that focus on long-run balanced growth paths. Thinking about market structures that emerge immediately after trade liberalization, however, requires to depart from symmetric long-run views. Short after a fundamental change in the economic environment, there are asymmetries, differences in market power and competition behaviour which then may or may not gradually and slowly disappear over time. This is the approach we take here. We start from two countries in autarky, let them trade and follow their evolution over time from the moment they open up to trade until the new long-run equilibrium.

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, $n^A + n^B = n + n_d$.

4.2.2 *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

$$U^i(t) = \int_t^{\infty} \exp[-\rho(\tau - t)] \ln C^i(\tau) d\tau \ . \tag{4.1}$$

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

$$\frac{\dot{E}^i(t)}{E^i(t)} = r(t) - \rho \ . \tag{4.2}$$

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

$$x_j = \frac{(p_j)^{-\varepsilon}}{n_m(p_m)^{1-\varepsilon} + n_d(p_d)^{1-\varepsilon}} \left(E^A + E^B\right) . \tag{4.3}$$

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 equally priced, if monopolistically supplied,

$$p_m = w/\alpha, \tag{4.4a}$$

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

$$p_d = w/m \ (\leq p_m), \tag{4.4b}$$

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

$$\dot{n}_m^i = \Lambda L_R^i K_n, \tag{4.5}$$

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 normalise 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 a blueprint for a new monopolistic variety equals its development costs,

$$v_m = c_R^i = w/K_n \ . \tag{4.6}$$

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

$$v_m = \int_t^{\infty} \exp\left[-(R(\tau)-R(t))\right]\pi_m(\tau)\,d\tau, \tag{4.7}$$

where profits are $\pi_m = (1-\alpha)p_m x_m$ and $R(u) = \int^{u} r(s)\,ds$.

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

$$L_R^i + L_m^i + L_d^i = \frac{\dot{n}_m^i}{K_n} + n_m^i x_m^i + n_d s^i x_d = L^i . \tag{4.8}$$

4.2.3 *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 chapter 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: trade in goods which increases the number of varieties available for consumption, trade in capital which allows intertemporal consumption smoothing and, finally, an increase in the stock of knowledge available from abroad. The scope of this chapter 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, already. Unfortunately, the present setup does not allow a distinction of consumption smoothing effects from competition effects[25]. 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 international knowledge spillovers under autarky does not ignore or question empirical results as e.g. Coe, Helpman and Hoffmaister (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. Neither does this approach deny the fact that trade usually

[25] The effects of consumption smoothing in models of the type used here are studied in Wälde (1996).

comes "as a package". Starting trade relations with a foreign country involves many interactions which all have some positive or negative effect. A potentially welfare increasing effect due to international trade lies in relative specialization due to differences in relative factor endowment. We neglect this (and other possible) effects without claiming that they are of no importance or are small compared to the present effect.

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,

$$g^A = g^B = (1-\alpha)\frac{K_n}{n^A+n^B}L - \alpha\rho, \quad \frac{K_n}{n^A+n^B} \leq 1 \ . \tag{4.9}$$

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

$$n^A/L^A = n^B/L^B \ . \tag{4.10}$$

Factor price equalization

The mechanism underlying 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 process[26], factor rewards equal because output prices are equal. To proof factor price equalization, following Wälde (1995), assume that monopolistic firms in, say, country A charge a higher price for varieties than firms in country B. Then, demand for varieties produced in country A and real returns are lower, $\pi_m^A/v_m^A = \pi_m^B/v_m^B$. Differentiating (4.7) with respect to time gives the usual arbitrage condition of the capital market $\dot{v}_m^i/v_m^i = r - \pi_m^i/v_m^i$. Since the costs of financing R&D is the same for every investor due to perfect capital markets, the lower returns in A would have to be compensated for by higher growth of firm values in country A.[27] Higher growth of firm values feeds back to lower real returns and therefore requires still higher growth of firm value. This is not

[26] 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.

[27] $\dot{v}_m^A/v_m^A > \dot{v}_m^B/v_m^B \leftrightarrow -\pi_m^A/v_m^A > -\pi_m^B/v_m^B \leftrightarrow -p_m^B x_m^B/v_m^B > p_m^A x_m^A/v_m^A \Rightarrow x_m^B > x_m^A \wedge p_m^A > p_m^B$

feasible and contradicts the long-run equilibrium properties of the model, where firm values equalise, $v_m^A = v_m^B$. Hence prices of monopolistic varieties must instantaneously equalise at the moment countries open up to trade, which leads to an instantaneous equalization of wages.

This proof of factor price equalization employs equation (4.6) 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, $v_m < w^B/K_n$, (4.6) would be violated and factor prices would not equalise. 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 analysed by using a differential equation system in two auxiliary variables. One is the ratio of the total 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 (4.4), $\mu = p_d/p_m$, the system reads[28],

$$\frac{\dot{\eta}(t)}{\eta(t)} = L - \alpha\left[1 + \frac{\mu^{-\varepsilon}(1-\mu)}{\eta(t) + \mu^{1-\varepsilon} - 1}\right]\delta(t), \tag{4.11}$$

$$\frac{\dot{\delta}(t)}{\delta(t)} = \delta(t)\left[1 + \frac{1-\mu^{1-\varepsilon}-\alpha(1-\mu^{-\varepsilon})}{\eta(t) + \mu^{1-\varepsilon} - 1}\right] - \rho - L\ . \tag{4.12}$$

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

[28] The first equation is found by inserting (4.8) into $\dot{\eta}/\eta = \dot{n}_m/K_n = \dot{n}^A/K_n + \dot{n}^B/K_n$. The second by differentiating (4.7) with respect to time and inserting this plus demand equations into $\partial \ln\delta/\partial t$ and rearranging.

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 countries.[29]

4.3 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.

4.3.1 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 (e.g. by one firm buying the foreign competitor) 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 analyse 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 (4.11) and (4.12) 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

$$g^w = (1-\alpha)L - \alpha\rho \ . \tag{4.13}$$

In the case of no overlap, $n^d = 0$, the auxiliary variable η is infinity and terms between the brackets in both (4.11) and (4.12) again vanish. The growth rate is again given by (4.13). The same is true if firms

[29] 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.

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, both equation (4.11) and (4.12) simplify.

However, when comparing these situations to autarky, differences arise. If there is no overlap, trade does not increase the growth rate since firms enjoy international spillovers already in autarky and growth rates in (4.9) and (4.13) are the same. The increase in the size of the market which tends to increase R&D incentives is exactly offset by a reduction in R&D incentives through the increase in the number of competitors (Grossman and Helpman, 1991, p. 245). If there is an overlap and firms collude, the innovation rate immediately jumps from its autarky (4.9) to its trade value (4.13). The main difference between autarky and free trade of goods 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.

For this reason the long-run growth rate under trade may exceed the autarky growth rate even in the presence of an overlap, independently of duopolists's behaviour. The difference with a situation without an overlap or with collusion is then that some varieties are provided duopolistically and at a relatively lower price, $\mu < 1$.

4.3.2 Competition and growth in the short run

International competition is a two-dimensional phenomenon. The first dimension is the *scale* of competition. It increases with the overlap as captured by n_d/n $\left(= \eta^{-1}\right)$. 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 a state variable in the two equations describing the world economy (4.11) and (4.12). 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 4.2.

Figure 4.2 *Intensity of competition, markups and relative prices*

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

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 monopolist[30]. 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, $\alpha \leq \mu \leq 1$.

Clearly, this is a simple view of duopolistic competition. One could argue that firms should not content themselves with such passive strategies and rather try to increase their market shares. There are two reasons why the present chapter sticks a traditional approach. Even if firms competed with each other actively, they would charge a price that is lower than the price of a monopolistic variety. Since this is the mechanism that leads to the central effects stressed in this chapter, results would not change. Second, similar to the argument made above with respect to relocation of varieties on the goods market, firms would start competing actively with each other (i.e. by investing) only if returns to these investments are high enough, compared to returns from investing in completely new varieties. If returns on R&D are higher than returns on active strategies, firms would remain passive and simply share markets.

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 (4.11) and (4.12) can be illustrated with the help of Figure 4.3.

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 infinite. The vertical axis plots the ratio of nominal world expenditure to the value of R&D times the number of different varieties,

[30] Under Cournot competition, each firm takes output of the other firm as given. Optimal quantities are then implicitly defined by $p\left(1-(2\varepsilon)^{-1}\right) = w$, 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.

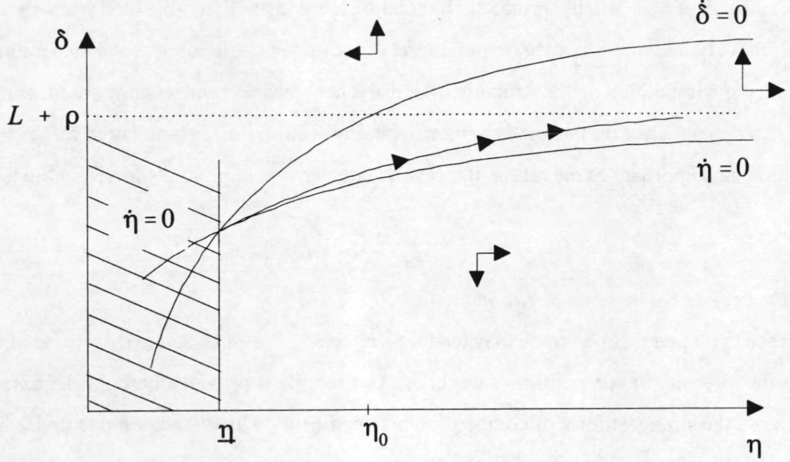
$\delta = E/(n v_m)$. The zero-motion lines $\dot{\eta} = 0$ and $\dot{\delta} = 0$ depict combinations of η and δ for which the change in η and δ, respectively, are zero. The intersection point of these lines,

$$\underline{\eta} = \left(\mu^{-\varepsilon} - 1\right)\frac{\alpha\rho}{(1-\alpha)L - \alpha\rho} \tag{4.14}$$

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 $\left(\eta < \underline{\eta} \Leftrightarrow n_m < (\underline{\eta}-1)n_d\right)$, innovation in both countries comes to a halt.[31] 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 equation (4.14). 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 in Figure 4.3. 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 (4.16), the further the threshold level moves to the left and the less likely an economy is trapped in a no-growth situation. The threshold level is lower if the willingness to save or if the productivity of labour in R&D is high.

[31] The derivation of the reduced form (4.11) and (4.12) 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 (4.14), 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 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.

Figure 4.3 *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 insights 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.

The mechanism that leads to either a halt of innovation activity or 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 more intense competition between duopolists is, as can be seen from relative demand, derived from (4.3), $x_d/x_m = \left(p_d/p_m\right)^{-\varepsilon} = \mu^{-\varepsilon}$. This alters the allocation of resources not only among 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, $\eta > \underline{\eta}$, 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 (4.13) in the long run.

Growth rates in the case of Bertrand competition

It is interesting to see that opening up to trade may lead for *any* scale of competition to a decrease of the innovation rate if the intensity of competition is too high. An example 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 (4.11). Though this expression is not easily compared to the autarky growth rate (4.9), an upper and lower boundary can be found by exploiting the boundary values given for $\delta(t)$. Equation (4.13) shows that the innovation rate is the higher, the lower, ceteris paribus, the value of $\delta(t)$. Figure 4.3 demonstrates 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 (4.13). The lower boundary of δ is obtained by solving $\dot{\delta} = 0$ in (4.12) for δ. After some rearrangement, one finds that the growth rate after trade sets in is bounded from above as

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

Comparing the autarky innovation rate (4.9) to the upper boundary of the trade innovation rate shows that the autarky innovation rate is higher than the trade innovation rate if $\alpha(\mu^{-\varepsilon}-1) \geq 1$.[32] Numerically solving this (in)equality learns that it always obeyed in the case of Bertrand competition. If competition is too fierce, and 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.

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

[32] 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 $z < 1$.

knowledge grows at the same rate as the number of varieties. As can be seen from the autarky growth rate expression (4.9) it is precisely this gap between knowledge K_n and number of firms $n^A + n^B$ that keeps the autarky innovation rate low.[33] Growth is reduced due to the competition effect described above. If the latter effect 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 Eastern Europe , little innovation or welfare losses are to be expected. It will be shown in section 5, 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.

Discussion

Two recent papers by Aghion and Howitt (1998) 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 is empirical work by Blundell, Griffiths and Van Reenen (1995) and Nickell (1996) which 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 consider 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, but in the long-run, when the demand diverting effect tends

[33] 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 earlier..

to disappear, innovation activity goes back to its previous level. The intensity of competition and therefore the market shares remain unchanged, however.

4.4 International competition and welfare: comparing autarky and free trade

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? The present model allows for a rich variety of cases and we will only discuss two examples. They qualify the traditional argument that countries gain from free trade through a wider choice of varieties. General results are hard to derive. After trade liberalisation the growth rate of the world economy changes over time. An analytical expression for welfare in the trade regime cannot be derived, rendering an explicit comparison between autarky and free trade impossible. The general conclusion from the two examples however is that trade is inferior to autarky if dynamic losses following 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. In other words, the welfare consequences of trade liberalization are ambiguous.

The first example is trivial. If the overlap is negligibly small (but not zero), countries gain from trade because the number of available varieties increases and consumers value variety. This is the traditional argument. The second example requires more explanation. We will study an extreme case in which two identical countries find themselves in a no-growth trap after opening up to trade. In a situation of a complete two-sided overlap both countries will experience losses from trade, unless in the autarky the economies are dynamically inefficient and the autarky growth rate exceeds the socially optimal rate.[34]

In the case of a two-sided overlap, 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 realised since here a combination of fierce and large scale competition stops innovation. What remains to be seen is whether the fall of the innovation rate leads to an increase or a decrease in the welfare level.

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 (4.1). Since there is no trade, an

[34] This example does not make a specific assumption about the autarky growth rate.

economy's consumption level per variety equals output of the representative firm. Relevant equilibrium properties are then $n^i(\tau) = n_0^i \exp\left[g^i(\tau - t_0)\right]$ and $x^i(\tau) = x_0^i \exp\left[-g^i(\tau - t_0)\right]$, 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,

$$U_{aut}^i = \frac{1}{\alpha\rho}\left[\ln(n_0^i) + \alpha\ln(x_0^i) + \frac{1-\alpha}{\rho}g^i\right]. \qquad (4.15)$$

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

$$x_0^i = \left(L^i - g^i\right)/n_0^i . \qquad (4.16)$$

Free trade welfare levels can be computed the same way as the autarky level. 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. The utility function (4.1) becomes

$$U_{trade}^i = \frac{1}{\alpha\rho}\ln\left[n_d(c_d^i)^\alpha\right], \qquad (4.17)$$

where $n_d = n_0^i$. Since all factors are used for production and no country has any foreign wealth, domestic demand for duopolistically supplied varieties, c_d^i, equals domestic production In the absence of R&D activity, factor market clearing conditions (4.8) imply

$$c_d^i = \frac{L^i}{n_d} . \qquad (4.18)$$

Gains from trade can then be computed by subtracting the autarky welfare level (4.15) from the trade welfare level (4.17), with appropriate consumption levels (4.16) and (4.18) 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

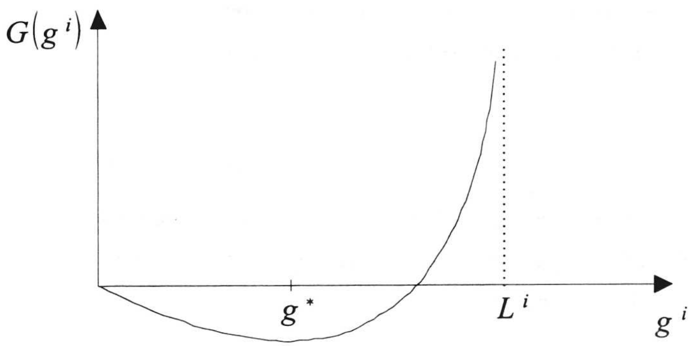
$$G\left(g^i\right) \equiv \alpha\log\left(\frac{L^i}{L^i - g^i}\right) - \frac{1-\alpha}{\rho}g^i > 0 \ ..$$

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. 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, does not induce reallocation nor does not bring any gains 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

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

and $\lim_{g^i \to L^i} G(g^i) = \infty$, the gains from trade function can be plotted as in Figure 4.4.

Figure 4.4 *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 decentralised 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 themselves 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 increased output per variety.

The two extreme examples – no overlap or a complete overlap – clearly demonstrate the two opposing welfare effects of trade liberalization: on the one hand static welfare gains and on the other hand (the strong possibility of) dynamic welfare losses. The basic question in the general case of ongoing innovations under free trade is therefore whether static gains of more varieties outweigh dynamic losses associated with less innovation. More specifically, what is the critical level of the number of duopolistic varieties n_d causing these dynamic losses? Or, equivalently, in terms of Figure 4.3, 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 functions 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 $\eta_0 > \eta^*$.

Assume that the integrated world economy finds itself in a no-growth trap if (and only if) there is complete two-sided overlap, which means $\eta = 1$ in Figure 4.3. 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 (4.9) equals the one under free trade (4.15). 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 $\eta \to \infty$. 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.

4.5 A rationale for (temporary) tariffs?

The last section has considered conditions under which trade equilibria are 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 policy 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. Put differently, can, in the absence of autarky distortions, free trade that is characterized by an efficient factor allocation be welfare reducing?[35]

One obvious difference between the current model and other, perfect competition models is the market structure and the changes therein owing to international trade. This has several consequences. The changing market structure leads to more competition, changing relative prices between otherwise identical varieties. This leads to a factor reallocation which is not welfare maximizing. Also, the changing market structure leads to a lower incentive to innovate. The general question is whether any of these changes are not internalised 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 tariffs. 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.

4.5.1 The distortions to be corrected for

Why should international trade call for market intervention? Why is central coordination of decisions necessary that cannot be optimally taken on a decentralised 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 producers, consumers and entrepreneurs. This is the one which is responsible for factor reallocation, falling innovation rates and welfare losses as a result of international trade.

[35] 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.

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 monopolistic and duopolistic varieties. The price differential is a distortion. In a second-best world, in which producers have market power, more competition is not necessarily welfare-improving. Consumers change their demand patterns, consuming different, sub-optimal amounts of otherwise identical varieties. Moreover, not only do producers ignore the consequences for consumers, but also consumers do not take into account the effect of changing demand patterns on innovation incentives. The appendix shows that for a given price differential, $\alpha \leq \mu < 1$, a central planner chooses a higher growth rate, even if the central planner does not take into account the international knowledge spillovers.

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 decentralised 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 *in*creases. Since opening up to trade leads, if anything, to a *de*crease of the innovation rate compared to the long-run (and hence also immediately feasible) world innovation rate g^w (4.13), 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.

4.5.2 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 (4.4b) equals the one of monopolists (4.4a). A tariff that certainly achieves this is an infinite one since it simply prohibits trade.[36] 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 (4.13). Discriminative tariffs are welfare increasing because they allow to correct the price distortion between monopolistic and duopolistic varieties. The statutory tariff rates are permanent since duopolistic varieties continue to exist. However, the average tariff rate falls over time as a consequence of a steadily decreasing market share of duopolistic varieties. In this sense protection is only temporary.

4.5.3 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 that apply to *all* imports. This section will discuss a second-best policy: a combination of a R&D subsidy and a uniform tariff. The R&D subsidy or tax allows the innovation rate to be set optimal. The price distortion, as a result of international competition, generally implies that decentralised decision-making does not give the outcome a central planner would choose. We further focus our attention to a uniform tariff. Provided that a uniform tariff is an efficient instrument for changing the price of duopolistic varieties, an optimal tariff rate exists. The optimal rate is a function of the overlap and decreases over time.

A uniform tariff alleviates a distortion, but also produces one. It diminishes the price differential between monopolistic and duopolistic varieties, but also creates a price differential between domestic and foreign varieties. An optimal tariff has to balance the two distortions. The weight attached to either distortion depends on the overlap. If the number of duopolistic varieties is negligible and $\eta \to \infty$, a tariff only produces a distortion and a welfare loss. The tariff should then be zero. However, if the number of (foreign) monopolistic varieties is almost negligible and $\eta \downarrow 1$, a rationale for temporary tariff appears. If the tariff is an efficient instrument to change the relative price of duopolistic varieties the optimal tariff rate is positive. More specifically, it can be shown that if $\sigma = \dfrac{\partial \mu}{\partial 1+t}\dfrac{1+t}{\mu}$ and if $\eta \downarrow 1$ in the case of complete two-side overlap, the optimal rate is positive. In the case of Bertand competition $\sigma = 1$ and this condition if fulfilled, but in the case of Cournot competition $\sigma \geq 1/2$ and the optimal rate is not

[36] In the case of Cournot competition and Bertrand competition a prohibitive tariff rate is not infinite, but equals $1/\varepsilon - 1$.

necessarily positive. In either case a uniform tariff is only temporary. Trade liberalization is gradual rather than sudden, but will eventually lead to a situation of free trade. As innovations occur and the number of monopolistic varieties increases, the distortionary effect becomes more and more important and the optimal tariff rate declines.

In the absence of R&D subsidies the rationale for a uniform tariff is likely to be stronger. A uniform tariff partly corrects the price differential between monopolistic and duopolistic varieties. It thus shifts demand towards monopolistic varieties, may raise the return on R&D and may consequently boost innovative activity. Again the tariff is temporary, because the growth-enhancing effect of a tariff is negligible if the overlap is (infinitesimally) small.

4.6 Concluding remarks

Since consumers value variety, one of the gains from international trade is that it expands the range of available products. This gain does not immediately materialise after trade liberalization. Countries may have varieties in common. Romer and Rivera-Batiz (1990) and Grossman and Helpman (1991) point out that in that case trade will raise the rate of economic growth in the long run. In autarky countries engage in duplicative, overlapping R&D activities. If imitation does not contribute as much as innovation to the pool of public knowledge, duplication is not efficient. International trade provides an incentive to avoid duplication, and brings about a more efficient allocation of resources. It leads to competition among producers of blueprints for new varieties, even if these blueprints are not traded. Competition on the goods market ensures that introduction of a new variety is more profitable than duplication of an already existing variety.

Formal models, capturing these ideas about gains from trade, are static (e.g. Krugman 1979, 1981) or confine attention to balanced-growth paths (e.g. Grossman and Helpman 1991). They are concerned with the long-run effects of trade. This chapter acknowledges the contributions of these models, but takes a different tack by focussing on transitional dynamics. The result is that suddenly and complete removing impediments to international trade, inducing competition on the goods market, does not necessarily raise the rate of economic growth or welfare.

Liberalizing trade between two countries that have some varieties in common, induces competition between producers of these varieties. The relative price of duopolistically and monopolistically provided varieties becomes lower, even though in every other respect the varieties are similar. Also, the relative price of current and future consumption changes. Demand shifts from monopolistic to duopolistic varieties and thus from new to already existing ones, lowering profits and depressing the reward for innovative activities. The effect of competition is thus ambiguous. On the one hand it increases the efficiency of R&D, by avoiding overlapping activities, but on the other hand it lowers the return on R&D. If the scale or the intensity of competition is too large, sudden trade liberalization lowers the innovation rate or may even stop the innovation process. The consequence is that the two countries do not necessarily benefit from free trade.

The chapter shows that the gains from trade do not materialise automatically. The two countries better agree upon gradual liberalization of international trade, rather than suddenly and completely removing trade barriers. Temporary tariffs and also R&D subsidies counter the problem of too much competition and its consequences. The analysis also suggests that lengthy trade negotiations are a blessing in disguise. They prepare producers of blueprints for the eventuality of competition, already avoiding the waste of duplicative activities, reducing the overlap in the range of available varieties and decreasing the scale of competition.

Considering trade between more than two countries gives further support to the idea of gradual, managed 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 is likely to increase with the number of countries, and the price of these varieties is likely to decrease. For example, in the case of Cournot competition the mark-up declines if the market share falls. Also collusion now requires more coordination and is harder to achieve. The scale and the intensity of competition will thus only increase if trade liberalization concerns more than two countries.

Appendix A The reduced form equations for the world economy

Equation (4.12) is found by inserting (4.8) into $\dot{\eta}/\eta = \dot{n}_m/K_n = \dot{n}_m^A/K_n + \dot{n}_m^B/K_n$. To this end, rearrange (4.8) to $\dot{n}_m^i/K_n = L^i - n_m^i x_m^i - n_d s^i x_d$ and obtain $\dot{\eta}/\eta = L - n_m^A x_m^A - n_m^B x_m^B - n_d x_d$. 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 (4.3) yields

$$\dot{\eta}/\eta = L - n_m \frac{p_m^{-\varepsilon}}{n_m p_m^{1-\varepsilon} + n_d p_d^{1-\varepsilon}} E - n_d \frac{p_d^{-\varepsilon}}{n_m p_m^{1-\varepsilon} + n_d p_d^{1-\varepsilon}} E = L - \frac{n_m p_m^{-\varepsilon} + n_d p_d^{-\varepsilon}}{n_m p_m^{1-\varepsilon} + n_d p_d^{1-\varepsilon}} E$$

$$= L - \frac{n_m p_m^{1-\varepsilon} + n_d \mu^{-\varepsilon} p_m^{1-\varepsilon}}{n_m p_m^{1-\varepsilon} + n_d p_d^{1-\varepsilon}} \frac{E}{p_m} = L - \frac{n_m + n_d \mu^{-\varepsilon}}{n_m + n_d \mu^{1-\varepsilon}} \alpha \frac{E}{w}$$ where the last but one equality used $p_d = \mu p_m$.

As $\alpha E w^{-1} = \alpha\delta$ and $\dfrac{n_m + n_d \mu^{-\varepsilon}}{n_m + n_d \mu^{1-\varepsilon}} = \dfrac{n_m + n_d + n_d \mu^{-\varepsilon} - n_d}{n_m + n_d + n_d \mu^{1-\varepsilon} - n_d} = \dfrac{\eta + \mu^{-\varepsilon} - 1}{\eta + \mu^{1-\varepsilon} - 1} = 1 + \dfrac{\mu^{-\varepsilon} - \mu^{1-\varepsilon}}{\eta + \mu^{1-\varepsilon} - 1}$, we obtain

equation (4.12).

Equation (4.13) can be obtained by differentiating (4.7) with respect to time, $\pi_m + \dot{v}_m = r v_m$, and inserting this with the expenditure equation (4.2) into $\dot{\delta}/\delta = \dot{E}/E - \dot{n}/n - \dot{v}_m/v_m = -\rho - \dot{\eta}/\eta + \pi_m/v_m$,

where $\dot{\eta}/\eta = \dot{n}/n$ has been used. The profit ratio can be written as $\dfrac{\pi_m}{v_m} = (1-\alpha)\dfrac{p_m x_m}{v_m}$

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

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

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

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

$= 1 + \dfrac{-\alpha(1-\mu^{-\varepsilon}) + 1 - \mu^{1-\varepsilon}}{\eta + \mu^{1-\varepsilon} - 1}$, we obtain (4.13).