Some Popular Arguments Against Free Trade and Their Limitations

Philip Sauré
Universitat Pompeu Fabra
Barcelona

Advisor: Jaume Ventura

October 5, 2005

Dipòsit legal: B. 7522-2006
ISBN: 84-689-6681-9

Contents

Acknowledgements

I would like to thank many people. Above all, I thank Jaume Ventura for his invaluable advice. Without his patience and kind help this dissertation would not have come into being. Further, my work hugely benefited from comments and discussions for which I particularly thank Fernando Broner, Antonio Cabrales, Antonio Ciccone, Juan Carlos Conesa, Jordi Gali, Gino Gancia, Teresa Garcia Milà, Fabrizio Germano, Fernendo Guirao, Christian Haefke, Doh-Shin Jeon, Maria del Mar Rubio, Albert Marcet, Kiminori Matsuyama, Andrea Pescatori, Diego Puga, José V. Rodríguez Mora, Francesc Ortega, Romain Ranciere, Michael Reiter, Lutz Weinke, and the participants of the workshops at the Universitat Pompeu Fabra. Finally, I thank many friends and my family for a very good time and for helping me through the harder episodes of the last years. Financial support of the Agència de Gestió d'Ajuts Universitaris i de Recerca is thankfully acknowledged.
The usual disclaimer applies.

Florence, September 2005 Philip Sauré

Foreword

Little in economic theory is as widely accepted as the benefits from international trade, and still barriers are deliberately preserved or put in place, massively reducing trade flows. The attempt to understand this apparent inconsistency motivated my research and finally led to the present doctoral thesis.
In the limited scope of this work, a discussion of trade policy must remain either superficial or incomplete. I chose to restrict the analysis to two objections to free trade, often encountered in public discourse. Following common terminology, the underlying reasoning is summarized as "infant industry argument" and "strategic protection of essential commodities", respectively. Standard general equilibrium formalization is used to conduct the analysis, offering new perspectives on the effects of trade policy and leading to insights which should be of use for a critical understanding of trade policy.

The first chapter addresses a critique of trade liberalization that is well known as "infant industry argument". A basic model encapsulates its main point by illustrating how developing countries can achieve higher long-run growth by shielding their high-technology industries from international competition. The simple formulation then allows for several tractable extensions leading to some severe qualifications of the infant industry reasoning. Most importantly, its logic is shown to fail in presence of different technological generations. Already under mild demand complementarities for high-technology goods, heavy protection makes developing countries stick to outdated, low-growth technologies. Trade liberalization, on the other hand, can lead to the adoption of high-growth technologies. The implied growth dynamics diametrically opposes the predictions of the standard infant industry argument: in the extended setup developing countries experience poor growth rates in a period following trade liberalization but their long-run economic growth is enhanced after a transition process.
Such sharp contrasts in predictions suggest new strategies for future test of the effects of protection on development. Tests could aim at growth rates of developing countries; more promising, however, seems to follow the line of recent empirical literature on the effects of trade on sectoral labor allocation. A further extension of the model helps to understand the effects of trade under learning externalities in a three-country world. This allows analyzing the effects of international competition among developing countries – an issue

that enjoys increased interest sparked off by the impressive trade integration of China and India and the rising fear their smaller competitors articulate in view this development. Unless such concerns, the model shows that trade integration can well be an “all-win-strategy”, creating enhanced growth rates in each county.
In sum, the first chapter points out harmful effects of trade barriers even under conditions that are normally thought to give good reason for protection.

The second chapter treats the protection of “strategically important” industries. Domestic production of vital goods, so common argumentation runs, deserves special protection to secure a minimum domestic supply. Lobbyists across industries frequently appeal to this particular logic, which, more often than not, seems fairly stretched. But its abuse does not make the argument entirely wrong and it is surprising that economic theory has so far missed to carefully examine it. I undertake first steps in this analysis, trying to answer when the argument bites and how, if any, protection should be granted.
To this goal, a two-country model is developed. In a repeated trade game with reputation building, all international trade agreements are required to be self-enforcing; protection can be granted through tariffs and subsidies. In the analysis, special attention is paid to the complementary role of tariffs and subsidies, reflecting on the one hand the prominent role these policies play in recent trade talks and allowing on the other hand a critical evaluation of international legislation put in action in the WTO rules.
It is shown that optimal commercial policy tends to favor comparatively disadvantaged and declining industries - an observation that is consistent with a number of empirical studies on protection. Moreover, essential commodities are optimally protected by a mix of tariffs and subsidies. Subsidies for domestic produces of essential goods effectively break market power of foreign suppliers and heavily reduce their incentives to defect on trade agreements. Therefore subsidies prove particularly effective in relaxing the self enforcement constraint.
An extension of the model reflects the restrictiveness of the conditions that drive the findings. It is shown that the main results are severely qualified when the countries' industrial structure exhibit strong rigidities. In this case the deliberate creation of mutual dependence serves as a commitment device and in fact enables countries to sustain free trade when it otherwise would not be self-enforcing.
In this way, the second chapter provides in a first part a rational for pro-

tection of strategic industries by actually endogenizing supply ruptures in a strategic trade game. In a second part, it highlights that the conditions for the logic to apply are quite demanding and sheds light on the limitations of the underlying reasoning.

In sum, the present work contributes to the literature on trade policy, focusing on two of the most common critiques of trade liberalization. The formal tools developed here hopefully help to critically assess the controversies about globalization and permit a rigorous evaluation of arguments that often are liberally used and abused by protectionists.

Chapter 1

International Competition, Learning by Doing, and Growth

Abstract: This chapter develops a tractable Ricardian model to assess the effects of trade integration on the income growth in developing countries. Two scenarios are analyzed. Focusing first on trade integration between an advanced and a developing economy, the model concisely replicates the infant industry argument. More importantly, it helps to identify a drawback of the infant industry argument, which previous literature had overlooked: protectionism can decrease long-run growth by reducing local demand for goods with high potentials of productivity growth, thereby hindering economic growth. A second part extends the model to a three-country scenario and addresses the effects of competition among developing countries. The trade integration of large developing economies has adverse static effects on the income of small developing economies by it increasing competition at the bottom of the product ladder. But under adequate conditions, the small developing economies are pushed up the production ladder and enjoy increased transitional and long-run growth, possibly leapfrogging the initial leader.

1.1 Introduction

This chapter addresses the effect of trade integration on the growth performance of developing countries under the hypothesis that learning by doing is a key factor of economic growth. It reevaluates the infant industry argument in a first part and analyzes in a second the effects of competition among developing nations.

The infant industry argument is about two hundred years old, extensively studied, and very well known. When certain industries, so it runs, generate knowledge by merely engaging in production, and this knowledge is appropriable by neither firms nor workers, then a temporary protection of these industries gives them the room to grow competitive. The argument enjoyed great popularity after World War II, when it was used to justify protectionist policies in post-colonized developing countries; extensive protection was meant to foster industrialization and thereby encourage economic growth (Baldwin [2003]). Not before some decades later the advances of the endogenous growth theory provided economists with the formal techniques to carefully analyze the channels between protectionism and economic growth. A most influential contribution is Young [1991], who demonstrated how protectionism can foster long-run growth in developing countries. Somewhat ironically, these theoretical achievements came at a time when a paradigm change had accomplished: policymakers and economists favored open trade regimes and a large part of the developing countries had liberalized their trade policy.

Its comprehensive and elegant formalization on the one hand and its downturn of political relevance on the other could have marked the end of the academic discussion of the infant industry reasoning. But recent years have seen renewed interest in the role of that argument in the context of economic development, inducing to a line of theoretical contributions (Leahy and Neary [1999], Miravete [2003], Kaneda [2003], and Melitz [2004]). At the same time, empirical studies aimed to evaluate the success of protectionism (Luzio and Greenstein [1995], Lee [1997], Das and Srinivasan [1997], Dozin and Vamvakidis [2003], Ohyama et al [2004]).

Somewhat surprisingly, the empirical studies have persistently tried to identify protectionism and its effects on industry productivities, while neglecting to look at the consequences trade liberalization. This is surprising as the infant industry logic has a straight implication: a turn to liberal trade policies increases international competition and should thereby make high-technology industries in less developed countries contract or disappear. I think that testing this implication has potential to systematically assess the infant industry argument. For a sketchy example take a look at Mexico's performance in high-technology sectors after its major trade liberalization

with the US and Canada, the foundation of NAFTA. The classification[1] of "Advanced Technology Products" (ATP) the US Census Bureau provides can serve as a narrow definition of "high-technology sectors". Instead of production data, which are hardly available, take trade volumes of these commodities between US and Mexico. Table 1 reveals that total Mexican exports of ATPs increased by roughly 400% between 1994 and 2004. Even more striking is the observation that Mexico was a net importer of the high-technology commodities at the foundation of NAFTA but turns out to be a net exporter ten years after. Within the ATP classifications the picture is roughly the same: in all ten categories, Mexican exports surged, and for all but two of them (Biotechnology and Electronics) the Mexican exports as share of total bilateral exports increased during the ten years of NAFTA. It appears that Mexico heavily linked its economy into the production chain of these advances and dynamic industries.
These observations are alarmingly at odds with the infant industry reasoning and conventional comparative advantage considerations.

Motivated by those puzzling facts and the renewed interest in the infant industry argument the first part of the chapter aims to reexamine the infant industry logic once again. To this purpose it develops a tractable model that encapsulates the infant industry argument and helps to identify one of its drawbacks that previous literature has failed to address. In particular, the model highlights the impact of protectionism on the demand structure of a developing country. It illustrates that under demand complementarities protectionism can reduce demand for industrial goods to a degree that eventually makes unprofitable the production in precisely those sectors whose promotion was originally intended. In this case protection not only fails to foster industrialization but even causes economic stagnation. For this mechanism to bite, there must be a substitute to industrial production available - such as a subsistence technology. If that is the case, very inefficient domestic industries are forced to pay wages at which workers prefer to make their living with a subsistence technology. Consequently, these industries exit production. Even worse, under demand complementarities among industrialized

[1] The ten categories are: Biotechnology, Life Science, Opto-Electronics, Information and Communications, Electronics, Flexible Manufacturing, Advanced Materials, Aerospace, Weapons, and Nuclear Technology. These categories exhibit dynamic development and discoveries and are considered to be "on the leading edge" of their fields (see Abbott et al 1989).

goods, this adversely affects demand for other high-technology commodities, and contagion thus causes a breakdown of large parts of industrialized sector. Conversely, trade liberalization disentangles demand complementarities on the country level and can open the way to industrialization. This mechanism offers an explanation for the amazing performance of Mexico's export performance in the "Advanced Technology Products".
However, also under free trade the presence of a subsistence technology substantially impacts the industrialization of a developing country: When there is limited world demand of those industrial goods the developing country has a comparative advantage in, the entire labor force of the developing country will not engage in industrial production. Instead, a dual economy establishes with part of the labor force living on a subsistence basis while the rest produces in the industrial sector. As a growing world economy demands more and more of the developing country's export goods, it gradually drys out the labor pool occupied with the subsistence-technology. After this transition is accomplished, an effect sets in that generates growth in the less developed country: With growing foreign output, the domestic exported goods becomes relatively scarce and, by improving its terms of trade, the less developed country imports growth[2].
The implied income dynamics are the following: during a transition period of a dual economy, income is pinned down by the subsistence-technology and growth is nil; only after the transition period the developing country's terms of trade improve and it enjoys imported growth. These implications stand in sharp contrast to the ones of the infant industry logic, which predicts that static gains from trade come at the price of reduced long-run growth.

The second part of the chapter addresses a more recent concern developing countries formulate in view of the trade integration of large developing economies, such as China. Those smaller developing countries fear that the integration of a large and labor abundant nation into the world market adversely affects their own development trajectories. Indeed, common knowledge based on Ricardian or Stolper-Samuelson considerations suggests that the integration of China harms other developing nations with similar factor endowments and production possibilities, and recent studies confirm that China's economic expansion and its extraordinary performance as a interna-

[2] Supposing that a developing county has a comparative advantage in those goods with no learning effects at all, the improvement in terms of trade is in fact the only source of growth for the developing country.

tional trader comes at the cost of the export possibilities of other East Asian and Latin American countries (Eichengreen et al [2004] and IDB [2005]). A drastic example gives the "Textile and Apparel" sector in, again, Mexico. Textiles accounted for most of Mexico's growth of manufactured export goods since the mid-1980ies and created some 190.000 formal jobs in Mexico. But the gradual reduction of external trade barriers in recent years increased the competition from China and led to a severe reduction in employment of about 20%.in this sector. With about half of Mexico's production cost, China was able to take over market shares from Mexico. Moreover, the estimated 150 million Chinese workers in rural underemployment will keep wages in China's low-skilled sectors at low levels for a while, such that in a liberalized world economy China is expected to be the world's factory in the "Textile and Apparel", while the same sector is expected to shrink further in Mexico. Notwithstanding the static losses that China's development can inflict on other developing economies, the second part of the chapter shows that the integration of a "big competitor" can also be beneficial for small developing countries by accelerating their economic development. Parallel to an adverse static effect, small developing countries may receive a "push up" the product ladder and start producing in sectors that generate knowledge and grant long-run growth. Thus, by freeing resources at the bottom of the product ladder, the economics integration of the big newcomer can set the small competitors on the track of fast growth and make them realize dynamic gains. The model shows that this positive effects may be strong enough to even make small developing countries leapfrog the industrialized countries, the initial leaders in terms of per capita income. During such growth trajectories, income gains not only come from increased domestic knowledge and productivity, the small developing countries also benefit from cheap imports from the large developing trade partner, a favorable effect that travels through their terms of trade. Consequently, if Mexico or other developing countries in East Asian and Latin American loose their Textile and Apparel sectors to China just to engage in advanced and high-technology production they can well gain from China's trade integration in a dynamic perspective.

Finally, the discussion relates to a recent stream of literature, which empirically assesses the effect of trade liberalization on labor allocation. Imbs and Wacziarg [2003] discover that "measures of sectorial concentration follow a U-shaped pattern" when plotted against per capita income. Both, cross section and time-series data reveal that the course of economic development tends to come along with a reduction in specialization in early stages and with higher international specialization in later ones. The present chapter exhibits patterns of specialization that are consistent with these findings.

The chapter is organized as follows. Section 2 develops a model that replicates the key features of Young's [1991] argument, introduces different technological generations and discusses the implications of this change. Section 3 treats the case of competition between less developed countries under free trade. Section 4 concludes.

1.2 The Basic Model

This section aims to illustrate how demand complementarities can make the infant industry reasoning fail. To this purpose, it exposes a reduced-form version of Young [1991] in a first step and shows in a second that minor changes in the basic setup have dramatic consequences for the growth performance of developing countries.

The model's broad framework is the following. Individuals are of constant mass and infinitely lived. At each date $t \in \mathbb{R}_+$ they consume an amount c_t of a final good and enjoy the utility $u(c_t)$. The flow of momentaneous utilities is discounted with the time preference rate ρ, so that the individual lifetime utility at time t is

$$U_t = \int_t^\infty e^{-\rho\tau} u(c_\tau)\, d\tau \tag{1.1}$$

There will be no capital, no storage technology and thus no savings decision. Only "knowledge" is accumulable and grows according to a learning by doing mechanism, which, as in Krugman [1987] or Young [1991], affects productivity positively and is entirely exogenous to firms and workers. Consequently, individuals who maximize (1.1) simply maximize income at each point in time.

Just as in Young [1991], two different cases will be distinguished: free and costless trade in goods as opposed to autarky. Autarky is meant to capture protectionist policies. Trade in assets will be ruled out but that assumption is not crucial.

1.2.1 The Infant Industry Argument

In the following paragraphs, I will develop a model that replicates the core features of the infant industry argument. It relies on the assumptions, which traditionally underlie the infant industry reasoning. In particular, I assumes a learning by doing process that is biased towards the goods advanced economies have a comparative advantage in. The model's description starts with a closed economy. The economy is endowed with a labor force of mass L, which is supplied inelastically. Consumers in the economy demand one final good (Y), which is produced out of two intermediates (X_i)

$$Y = (X_1^{1-1/\varepsilon} + X_2^{1-1/\varepsilon})^{\varepsilon/(\varepsilon-1)} \quad (\varepsilon > 1) \tag{1.2}$$

The intermediate goods, in turn, are produced according to linear technologies, using labor as the sole factor:

$$\begin{aligned} X_1 &= L_1 \\ X_2 &= AL_2 \end{aligned} \tag{1.3}$$

Consider first a closed economy under these conditions. Taking the final good Y as the nummeraire, marginal productivity of the intermediate goods determines their following demand functions

$$p_i = (Y/X_i)^{1/\varepsilon} \tag{1.4}$$

while a competitive labor market implies[3] $p_1 = Ap_2$. Combining these equations leads to

$$L_1 = \frac{1}{1 + A^{\varepsilon-1}}L \qquad L_2 = \frac{A^{\varepsilon-1}}{1 + A^{\varepsilon-1}}L \tag{1.5}$$

Equations (1.2) and (1.5) together give national output

$$Y = \left(1 + A^{\varepsilon-1}\right)^{1/(\varepsilon-1)} L \tag{1.6}$$

Suppose now that there is learning by doing, which is asymmetric in the goods and stronger in those goods, industrialized countries have a comparative advantage in - say X_2. For simplicity, assume the extreme case of no

[3] Note that productivity A is disembodied and atomistic individuals do not internalize their work's effect on accumulation of A such that the labor allocation (1.5) is not affected by intertemporal considerations.

learning in production of X_1 while the productivity of X_2-production evolves according to

$$\dot{A} = \mu \cdot X_2/L \tag{1.7}$$

Differentiating (1.6) with respect to time and using (1.3), (1.5), and (1.7) it is straight to see that the autarky growth rate is

$$g = \dot{Y}/Y = \mu \left(\frac{A^{\varepsilon-1}}{1 + A^{\varepsilon-1}} \right)^2 \tag{1.8}$$

which approaches μ as A grows large. A closed economy's long-run growth rate is therefore μ.

Now take two different closed economies of this type, called South and North (North variables denoted with *). As long as they coexist without trade, the income growth will converge in the long run[4]

$$\dot{Y}/Y - \dot{Y}^*/Y^* \rightarrow \mu - \mu = 0$$

Suppose now that these two economies, which previously lived in autarky, start to trade freely. Transport costs are negligible but labor is bound to stay within national borders.
Assume further that at the date of liberalization the countries are not identical but exhibit some technological differences. In particular, North (the advanced economy) has a comparative advantage in production of X_2. It can be shown (see Appendix) that for any initial conditions that imply $L_2 < L/\varepsilon$, or equivalently satisfy

$$A^* L^* > A^{\varepsilon} L - (A^{\varepsilon} + A)/\varepsilon$$

South ends up completely specializing on good X_1 within finite time. Under these initial conditions, South' productivity grows too slow relatively to North' and South is gradually pushed out of X_2-production. Assume in the following that this is the case, or to keep matters simple, that full international specialization occurs on impact when countries decide to trade. This amounts to assuming $p_1 > Ap_2$ and $p_1 < A^* p_2$ or

$$\begin{aligned} A^* L^* &> A^{\varepsilon} L \\ L^* &< (A^*)^{\varepsilon-1} L \end{aligned} \tag{1.9}$$

[4] There is convergence in growth rates here, but not in levels.

These conditions show that there is a lock-in effect in the specialization pattern: if conditions (1.9) hold initially, only North produces X_2 so that A^* grows but A does not. Thus, the specialization pattern carves in and consequently (1.9) must hold at any time after the trade integration.
Under complete international specialization world output grows according to

$$\dot{Y^w}/Y^w = \frac{(A^*L^*/L)^{1-1/\varepsilon}}{(1+(A^*L^*/L)^{1-1/\varepsilon})} \cdot \mu$$

and approaches μ in the long run as A^* grows large.

Now write s for South' economic size, defined as South' income relative to world income. Homothetic demand, complete specialization, and balanced trade imply $p_1(1-s)X_1 = p_2 s X_2^*$, which (together with equation (1.4)) gives

$$s = \frac{1}{1+(A^*L^*/L)^{1-1/\varepsilon}}$$

So s becomes zero in the long run. The growth rate of s is

$$\dot{s}/s = -(1-s)(1-1/\varepsilon)\dot{A}^*/A^* = -(1-s)(1-1/\varepsilon)\mu.$$

Combining these equations, South' and North' growth rates (which are $g = (\dot{sY^w})/(sY^w)$ and $g^* = ((1-\dot{s})Y^w)/((1-s)Y^w)$, respectively) take the following expressions

$$g = \frac{\mu}{\varepsilon}\frac{(A^*L^*/L)^{1-1/\varepsilon}}{(A^*L^*/L)^{1-1/\varepsilon}+1} \qquad g^* = \mu\left[1-\frac{1}{\varepsilon}\frac{1}{(A^*L^*/L)^{1-1/\varepsilon}+1}\right] \tag{1.10}$$

such that $g \to \mu/\varepsilon$ as A^* grows large. Since $\varepsilon > 1$, this means that South' long-run growth under free trade (μ/ε) is less than under autarky (μ).

$$g_{autarky} = \mu > \mu/\varepsilon = g_{trade} \tag{1.11}$$

Figure 1.1 illustrates and summarizes equations (1.8) and (1.10). The top panel shows that in autarky the growth rate of both countries converge since all countries produce and learn in the advanced sector. The bottom panel exhibits the effects of trade integration in particular for the less developed country: international trade makes it specialize in sectors with little learning effects and thereby reduces its productivity growth. Consequently, the

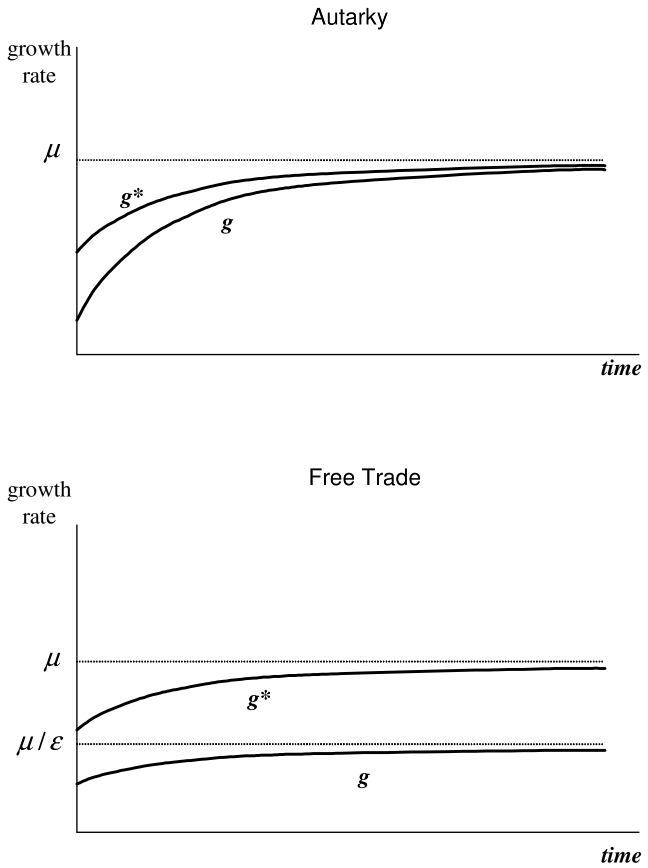

Figure 1.1: Growth Rates with One Technology Only

static gains from trade come at the cost of reduced long-run growth. At the same time the productivity gap widens without bound. This illustration summarizes the main finding of Young [1991].

One underlying assumption in this model - and others relating infant industries and economic growth - is that in autarky, each country is active in sectors that generate knowledge and therefore put the countries inevitably on the track of growth. This is a somewhat liner view of economic development, which can be questioned. The next paragraphs do precisely that and introduce two technological generations with only one of them creating knowledge.

1.2.2 A Subsistence Technology

The model developed up to here relies on the assumption that under autarky all countries keep alive their high-technology sectors, which grants learning by doing and leads to economic development. Put differently, at all production cost, domestic high-technology producers meet a positive demand. Obviously, this must not be the case. Very inefficient producers might need to sell their products at prices at which demand drops to zero. There might be some cheap substitutes, or consumers might like the goods in question, but not so dearly to pay any price for them. If that is the case, opting for autarky can hurt these sectors and protection induces a shutdown of sectors it originally intends to protect.
To formally reflect this, introduce now a substitute for the input good X_2 (called X_2 again to save notation). This substitute can be produced with a simple, outdated, no-growth technology according to

$$X_2 = bL_{2,Old}$$

The use of that technology in the whole production process renders

$$Y = (1 + B^{\varepsilon-1})^{1/(\varepsilon-1)} L_{Old} \tag{1.12}$$

of the final good. In the following, this technology will be labeled the Old technology. A consistent terminology calls the technology introduced earlier the New technology.
There is another way to interpret the Old technology. One can read it as an entirely unspecialized subsistence-technology with the constant return

$(1+B^{\varepsilon-1})^{1/(\varepsilon-1)}$. This interpretation has special appeal in the context of developing economies and will be adopted throughout the rest of this chapter.

On one unit of labor, Old returns $(1+B^{\varepsilon-1})^{1/(\varepsilon-1)}$ units while New delivers $(1+A^{\varepsilon-1})^{1/(\varepsilon-1)}$ units of the final good Y. Remember that knowledge is disembodied and workers do not internalize the growth effects, so Old is used if and only if

$$B > A \tag{1.13}$$

Now, if (1.13) holds, workers optimally choose Old to work with, productivity A in the idle sector stays constant and the economy does not grow. Coordination failure prevents adoption of the New, the superior technology[5]. If initial conditions are such that (1.13) does not hold, the scenario is identical to the one discussed in the previous case of one technology.

Assume in the following that an unfortunate country, South, is stuck to the Old technology and consequently stagnates. What happens to this country if it engages in free trade with an advanced economy, North? As will become clear shortly, the economic integration leads South to take up production of X_1, export it while importing X_2.
In terms of the model, South being stuck to the Old technology and North being advanced means that (1.13) holds for South but not for North. In addition, assume that South' labor force is large. If this is the case, trade integration leads to the following international production pattern. North specializes entirely on X_2-production, while part of South' labor force (L_1) produces X_1 and the rest of South' workers ($L_{Old} = L - L_1$) works with the Old technology. Wage equalization in South requires $p_1 = B$. With $X_1 = L_1$ and $X_2 = A^* L^*$ and (1.4) this gives

$$L_1 = \frac{A^* L^*}{B^\varepsilon}$$

The condition for North to specialize on X_2 is $p_1 < A^* p_2$. This condition is satisfied since (1.13) was assumed to be violated for North. This shows that the production pattern described indeed constitutes a static equilibrium allocation provided that $L > L_1$. (In precisely that sense South' labor force is assumed to be large.)

[5]Of course, there might be no coordination failure whatsoever when individuals are impatient, B is very large, or A is very small. In that case, the discounted flow of utility might be higher when working with B.

Next look at the dynamics of South and North incomes under the free trade regime. On impact of trade liberalization $L_1 = A^*L^*/B^\varepsilon$ is assumed to be less than L, but L_1 will keep growing as A^* grows. Thus, L_1 eventually hits its natural limit L, at which date South' entire labor force produces X_1. The summarizing equation is

$$L_1 = \min\left\{L, \frac{A^*L^*}{B^\varepsilon}\right\} \tag{1.14}$$

Thus, after trade integration, two qualitatively different periods will follow. First, the "transition period" during which the Old sector is successively drying out as a result of increasing L_1. Second, the "specialization period" which follows the transition period and during which South' labor force is fully allocated to the X_1-sector.
The income dynamics of South are very much different in the two periods. Note first that North produced X_2 only while South does not engage in X_2-production at all. This means that growth of productivities in the two countries are (remember (1.7))

$$\dot{A}^*/A^* = \mu \qquad \text{while} \qquad \dot{A}/A = 0$$

The wages are $w = p_1$ and $w^* = A^*p_2$. With (1.14) one calculates the world prices and the growth rates of South and North income during the transition period

$$g^* = \mu \qquad \text{and} \qquad g = 0$$

After the transition period, the respective growth rates are just like in (1.10) and South and North income grow at different rates in the long run:

$$g \to \mu/\varepsilon \qquad g^* \to \mu$$

Figure 1.2 illustrates these dynamics and contrasts them to the growth performance of the closed economies. The top panel shows that in autarky North grows while South sticks to the Old technology and stagnates. The bottom panel exhibits the growth rates of the two economies in the two different periods that follow a trade liberalization. The first period lasts the amount of time it takes for the growing world market to absorb South' labor supply. During this transition, South' growth is zero since national income

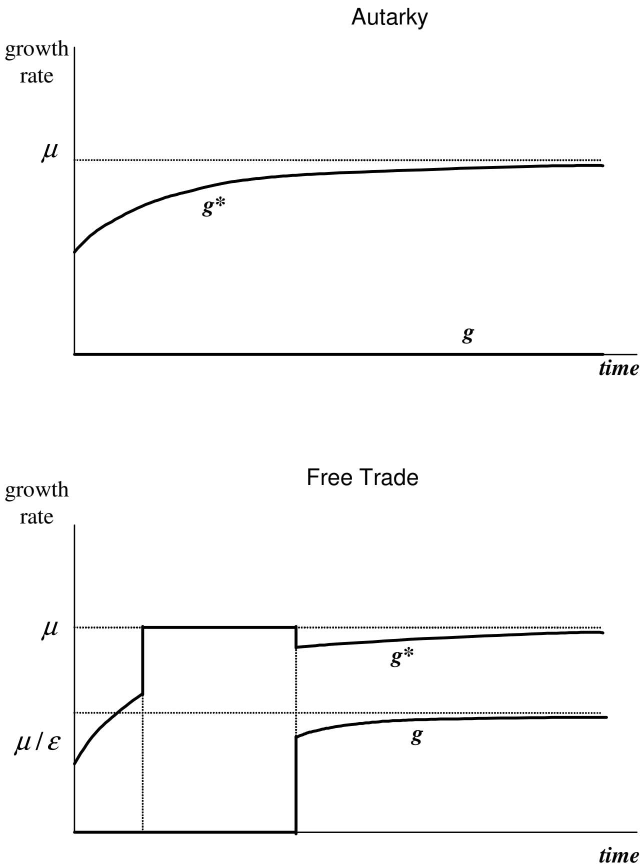

Figure 1.2: Growth Rates with an Old and a New Technology

equals labor income and its wages are pinned down by the Old technology: $w = (1 + B^{\varepsilon-1})^{1/(\varepsilon-1)}$. Only after the transition period is completed, South' wages start to rise. Growth, however, does not come from productivity growth but from an improvement in the terms of trade as goods produced in North become cheaper.
From North' point of view, the effect of trade integration is quite different: in the transition period the constant inflow of South workers in X_1-sector prevents the relative price p_1/p_2 from rising, so North' terms of trade is constant. Thus, although growing in only one sector, North does not experience decreasing returns. During this time growth of world output goes entirely to the pockets of North workers whose incomes grow at rate $g^* = \mu$. After the transition period, output of X_2 keeps growing and North runs into decreasing returns as the price of X_1 appreciates. The favorable conditions in which North' terms of trade stays constant comes to an end. Consequently, the growth rate drops back to moderate levels.

Note that under trade integration, the incomes in South and North diverge just as in the previous case because in the limit South grows strictly less than North:

$$\dot{(Y^*/Y)}/(Y^*/Y) \to \mu(1 - 1/\varepsilon)$$

South' autarky alternative, however, is no growth at all, which implies divergence at a much higher rate μ.

A comparison the model's two versions presented up to here reveals that the presence of the Old technology puts upside down the growth effects of trade integration for South. In the model of part 2.1 South' static gains from trade came at the cost of reduced long-run growth just like in Young [1991]. In the present discussion, however, the introduction the Old or subsistence technology implied that initial benefits of a trade integration were zero but South' growth take-off came after a transition period.
Yet also in the presence of the Old technology, South' long-run growth rates are less than North' and the respective incomes diverge. It seems that South' dilemma is to choose between bad and worse and it is unable to participate in high growth. Once again, this must not be the case. The next paragraphs illustrate how trade can induce developing countries to start production in advanced, high-growth sectors that were idle in autarky.

1.2.3 Differentiation in the Advanced Sector

Suppose that technologies are like in part 2.2 except that the production is subdivided into further steps. In particular, the intermediate X_2 good is produced out of two input goods z_i and according to the following production function[6]

$$X_2 = \left(z_1^{1-1/\varepsilon} + z_2^{1-1/\varepsilon}\right)^{\varepsilon/(\varepsilon-1)} \tag{1.15}$$

The input goods are produced with the input technologies

$$z_i = a_1 L_{2i} \qquad i = 1, 2$$

Following the parallel calculations that led to equations (1.5) one derives that within the X_2-sector, labor allocates to the sub-sectors according to

$$L_{2i} = \frac{a_i^{\varepsilon-1}}{a_1^{\varepsilon-1} + a_2^{\varepsilon-1}} L_2 \qquad i = 1, 2 \tag{1.16}$$

Thus, output of X_2 is

$$X_2 = \left(a_1^{\varepsilon-1} + a_2^{\varepsilon-1}\right)^{1/(\varepsilon-1)} L_2 \tag{1.17}$$

Writing

$$A = \left(a_1^{\varepsilon-1} + a_2^{\varepsilon-1}\right)^{1/(\varepsilon-1)} \tag{1.18}$$

for the composite productivity in the X_2-sector, one recovers exactly the earlier setup. Note that L_2 is still determined by equation (1.5) and the static equilibrium for a closed economy is determined with equations (1.2), (1.5), (1.17), and (1.16).

Assume that learning by doing now affects productivity of X_2-production through the two sub-sectors according to

$$\dot{a}_i = \mu \cdot z_i / L \qquad i = 1, 2 \tag{1.19}$$

In the case where the input goods z_i cannot be traded the scenario collapses to the one of the previous setup with (1.19) replacing (1.7). The condition for South to be stuck to the Old technology in autarky (condition (1.13)) is now modified to be

$$B > \left(a_1^{\varepsilon-1} + a_2^{\varepsilon-1}\right)^{1/(\varepsilon-1)} \tag{1.20}$$

[6] The assuption that the elasticity of substitution of the intermediate and input-level is identical is convenient but not essential.

Now suppose that intermediate and input goods can be traded freely across borders. All previous results go through unchanged under these assumptions but for one major qualification: South can be set on the track of fast economic growth through trade integration. To see this, set South' productivities in the z_i-sectors to $a_1 = a$ and $a_2 = 0$. As throughout the whole section, assume that in autarky South is trapped to B ((1.20) holds) and that L is large. When trade is liberalized, South workers will start to produce X_1. But now they will also enter the z_i-sector, provided that it pays high enough wages. The according condition is that South' wages in the z_1-sector exceed those of the X_1-sector: $p_1 < aq_1$. Using (1.14), (1.16), (1.18), and (1.4) this condition is equivalent to

$$\frac{B}{\left((a_2^*/a_1^*)^{\varepsilon-1}+1\right)^{1/(\varepsilon-1)}} < a \tag{1.21}$$

At the same time, North exits z_1-production if North wages in the z_2-sector exceed those of the z_2-sector: $a_1^* q_1 < a_2^* q_2$ or

$$\frac{q_1}{q_2} = \left(\frac{a_2^* L^*}{a_2 L_2}\right)^{1/\varepsilon} < \frac{a_2^*}{a_1^*}$$

With $X_1^* = 0$ and $z_1^* = 0$, and performing parallel calculations that lead to (1.14), one derives that

$$L_{21} = a^{\varepsilon-1} L_1 \qquad \text{and} \qquad L_1 = \frac{a_2^* L^*}{\left(B^{\varepsilon-1} - a^{\varepsilon-1}\right)^{\varepsilon/(\varepsilon-1)}} \tag{1.22}$$

Combining both equations leads to

$$\tfrac{1}{a}\left(B^{\varepsilon-1} - a^{\varepsilon-1}\right)^{1/(\varepsilon-1)} < a_2^*/a_1^*$$

which exactly coincides with condition (1.21). For an intuition for this concurrence assume that South engages in X_1- and z_1-production. Since South' wages equal the return on the Old technology, the price q_1 is fixed to be $q_1 = (1/a)(B^{\varepsilon-1}+1)^{1/(\varepsilon-1)}$ and North' wages in the z_1-sector must be constant and equal to $w^* = (a_1^*/a)w$. At the same time, South keeps up with any increase in z_2-output by supplying more of X_1- and z_1- goods, reallocating its labor force from the Old to the New technology. This fixes relative prices and implies that North meets constant returns to labor in the z_2-sector, too. Thus, both z_i-sectors offer wages which are independent of North' labor allocation. Only in a knife-edge case, which is ruled out here the wages in both sectors coincide. (Technically speaking, under North' diversification, one has $w^* = a_1^* q_1 = a_2^* q_2$ and $w = p_1 = aq_1 = (B^{\varepsilon-1} + 1)^{1/(\varepsilon-1)}$, which together with the fixed relative prices constitutes an over-identified system.)

The world economy gives now the following picture: there is complete international specialization in the New technology, with North only producing z_2 and South providing world output of X_1 and z_1, while still keeping alive the Old technology. This means that after trade liberalization the productivities a and a_2^* grow according to (1.19). A quick look at condition (1.21) confirms that here again the pattern of comparative advantage deepens and international specialization is preserved: the condition will hold after trade liberalization as long as some of South' labor force still uses the Old technology. When finally South' transition period is over, the conditions for North to stay out of the z_1 and X_1-sectors are, respectively, $q_1/q_2 < (a_2^*/a_1^*)^{1/\varepsilon}$ and $p_1/q_2 < (a_2^*/1)^{1/\varepsilon}$, or

$$\left(\frac{L^*}{L} \cdot \frac{1 + a^{\varepsilon-1}}{a^\varepsilon}\right)^{1/\varepsilon} < \frac{(a_2^*)^{1-1/\varepsilon}}{a_1^*} \qquad \text{and} \qquad \left(\frac{L^*}{L}(1 + a^{\varepsilon-1})\right)^{1/\varepsilon} < (a_2^*)^{1-1/\varepsilon}$$

which, too, exhibit a carve-in effect as a and a_2^* grow. Finally, notice that after South' transition period, its labor allocates to the two active sectors according to[7]

$$L_1 = \frac{1}{1 + a^{\varepsilon-1}} L \qquad\qquad L_{21} = \frac{a^{\varepsilon-1}}{1 + a^{\varepsilon-1}} L \tag{1.23}$$

such that South productivity and income growth converge to μ.

The relevant conditions (1.20) and (1.21) describe the range for intermediate values of productivity a

$$\frac{B}{((a_2^*/a_1^*)^{\varepsilon-1} + 1)^{1/(\varepsilon-1)}} < a < B$$

When these conditions hold, the following episode can be told about the economic development of South:
During an initial period the two economies coexist without trading. One of them - North - grows since it uses the New technology that consists of production including low-technology intermediate goods (X_1) and high-technology

[7] By $a = 0$, South never enters the z_2-sector.

input goods (z_i). The other economy - South - stagnates because it works with the Old technology. At some point in time, these economies decide to open up to trade and North specializes on one of the high-technology goods, while South picks up production in the low-technology and one of the high-technology goods. It supplies these goods cheaply to North since its wages are pinned down by the Old technology. In that period, South does not grow. At the date when South completely abandons the Old technology, its income starts to grow and it enjoys a long-run growth rate equal to the advanced trading partner.
By the forces of trade, South thus becomes a successful but lagged success story of economic growth.

Before closing this section, it is worth taking a look at the labor allocation in this model. It turns out that it offers an explanation for the relation between economic development and specialization Imbs and Wacziarg [2003] discover. In their empirical work the authors find that "measures of sectorial concentration follow an U-shaped pattern" when plotted against per capita income. The present model exhibits precisely this characteristic. Consider the labor allocation in the New technology[8]: While poor countries with very low productivities a_i only engage in X_1-production, medium-income countries produce in both, the X_1- and z_1-sector, and finally high-income countries completely concentrate on z_2-production. But not only a cross section analysis, also the time paths of a developing country exhibits this feature: at early stages, a developing country allocates very little of its labor to the z_1-sector when a is smaller than unity ($L_{21}/L = a^{\varepsilon-1}$ compare (1.23)). As productivity a grows, more and more of its labor force shifts towards the z_1-sector, first decreasing the degree of specialization and later increasing it up to complete specialization on z_1-production ($L_{21}/L_1 \rightarrow \infty$). Thus, the country diversifies during early stages of development just to reach later periods of high specialization.

This section has illustrated the adverse effects protectionism can have on economic development. While in a closed economy the advanced X_2-production lay idle, trade integration made the developing country participate in the high-technology production and enjoy economic growth. Subsection 1.2.3 has highlighted that the presence of relatively weak demand complementarities ($\varepsilon > 1$) is enough to cause contagion in the industrialized sector, in

[8] Imbs and Wacziarg [2003] analyze the manufacturing sector.

the sense that a very inefficient subsector (z_2) reduces demand for otherwise competitive subsectors (z_1) such that the entire industrialized production comes to a halt[9]. Trade integration, on the other hand, disentangles the demand complementarity between the z_i, makes production of at least a subset of high-technology goods profitable and spurs economic growth[10]. One consequence of this mechanism is that trade liberalization is followed by a stimulation of high-technology production in developing countries. The example of NAFTA and the following surge in Mexican production of "Advanced Technology Products" (ATPs) nicely illustrates this effect: in the decade after the treaty, Mexico's exports of the ATPs increased by roughly 400%. Looking at the bilateral trade balance with the US reveals an even more striking fact: Mexico, being a net importer of ATPs in 1994, turned to be a net exporter ten years later. This episode is consistent with the explanation offered in this section: after abolishing trade barriers, Mexico was able to extensively integrate in the production process of the dynamic and advanced goods production.

Table 1.1:
Trade in Advanced Technology Products.
Mexico - USA 1994 and 2004 (in 1994 US$)

	Exports 1994		Exports 2004		% Change		MEX Exp. / Total Exp.	
Category	MEX - USA	USA - MEX	MEX - USA	USA - MEX	MEX - USA	USA - MEX	1994	2004
Biotechnology	9,500	19,300	12,942	34,727	36.2	79.9	33.0	27.1
Life Science	145,500	258,000	1,265,187	314,428	769.5	21.9	36.1	80.1
Opto-Electronics	46,500	57,300	1,225,771	199,495	2,536.1	248.2	44.8	86.0
Information & Communications	1,666,600	2,325,700	11,809,521	6,178,447	608.6	165.7	41.7	65.7
Electronics	608,700	1,210,900	850,508	4,127,856	39.7	240.9	33.5	17.1
Flexible Manufacturing	700	213,800	414,960	324,502	59,180.0	51.8	0.3	56.1
Advanced Materials	1,700	53,100	78,968	67,095	4,545.2	26.4	3.1	54.1
Aerospace	35,700	605,200	148,070	769,094	314.8	27.1	5.6	16.1
Weapons	1,900	12,300	46,395	24,311	2,341.8	97.7	13.4	65.6
Nuclear Technology	0	9,200	81	29,943	-	225.5	0.0	0.3
TOTAL	2,516,800	4,764,800	15,852,404	12,069,896	529.9	153.3	34.6	56.8

Source: US Cesus Bureau

[9] Precondition is a relatively complex and diversified production in the industrialized production process and a rather plain and simple one in the self-subsistence technology - not a too unreasonable assumption after all.

[10] It is worth noting here that the demand functionin this model is assumed to be homothetic. Non-homothetic demand like in Matsuyama [2000] with more demand for high-technology goods at higher income levels obviously strengthen this effect.

The effect of trade integration on the demand structure described here constitutes one of the two main points of the chapter. It is illustrated with the help of a very simple and tractable model and sheds doubt on the claim that, when climbing up the product-ladder, competition "from above" is harmful. Another and more recent concern deals with competition "from below", i.e. the competition among developing countries for world markets. Developing countries on the track to industrialization observe with concern that large and labor-abundant nations India and China integrate into the world market. Increased competition in labor-intensive sectors is believed to harm countries in Latin America and the developing nations of East Asia.
But this competition "from below" can also have beneficial effects for the poor countries. The next section shows this second main point of this chapter. The tractable model of the present section is used to analyze a three country model and give some insights on the effect of competition among developing countries.

1.3 Competition Among Developing Countries

This section focuses on the effect of competition for market shares among less developed countries in a globalized economy. Common knowledge suggests that small developing countries and transition economies should fear the large pool of cheap labor the big nations China and India supply to the world market. This cheap labor, the argument runs, drives other economies out of prospering industries and undermines their development trajectory. The present section looks at this claim and develops some intuition on it.

1.3.1 A Push Up

Suppose that technologies are like in subsection 1.2.3. Unfortunately for the developing country South, trade integration will not automatically lead to activity in a high-technology sector. When South does not enter the z_1-sector, it seems to be doomed to low growth rates as in subsection 1.2.2. Quite surprisingly, competition from another developing country can set South on the road of fast long-run growth.
To see this, suppose that while trading with North only, South does not produce any of the z_i. The general conditions for South not producing z_i are

$a_i q_i < p_i$ or

$$a_i < \frac{a_i^*}{\left(a_1^{*(\varepsilon-1)} + a_2^{*(\varepsilon-1)}\right)^{1/\varepsilon}} \cdot (L^*/L)^{1/\varepsilon} \qquad i = 1, 2 \tag{1.24}$$

Assume now that South and North were trading for a while, South exporting X_1 and importing the z_i.
Suddenly, there appears a new potential trading partner: an economy called East (whose variables are characterized by a twiggle). East is initially in autarky, has a huge population $\tilde{L}$, possesses the Old technology, is capable to produce X_1 just like the rest of the world, but is inefficient in z_i- production.

The main interest will be the consequences of East's trade integration on South' economy. In order to simplify the setup, assume that $a_1^* = a_2^* = a^*$ for North' input productivities and $a_1 = a$ and $a_2 = 0$ for South'. Finally, let South' and North' labor force satisfy: $a^* L^* > aL$. With these simplification, the relevant conditions from (1.24) comes down to be

$$a < (a^* L^*/2L)^{1/\varepsilon} \tag{1.25}$$

Now, suppose that all trade barriers between East and South and North fall and East integrates to the world economy. Since East's labor force is very large, it does not fully allocate to the X_1-sector and consequently pins down the price of good X_1 to $p_1 = (B^{\varepsilon-1} + 1)^{1/(\varepsilon-1)}$. How does this affect the income of South citizens?
The first and obvious effect is that East competes with South in production of X_1. As East is assumed to be very large it will flood the world market with X_1 goods, pushing down the price and therefore this sector's wages all the way to the lowest possible level $(B^{\varepsilon-1} + 1)^{1/(\varepsilon-1)}$. This effect clearly harms South' workers and causes a depression in South. Beneficiary is North by an appreciation of its terms of trade. The situation appears to create clear-cut losers and winners.

But the entrance of the newcomer can have beneficial effects for South, too. In particular, the big newcomer can push South into production of z_1. As production input good z_1 exhibits potentials of productivity growth, this means that the "push up" by the large competitor sets the small country on a track toward increased rates growth.

Under the adequate condition, the production pattern of the world economy right after integration of East is

$$\begin{array}{lll} \tilde{X}_1 = \tilde{L}_1 & X_1 = 0 & X_1^* = 0 \\ \tilde{z}_1 = 0 & z_1 = a & z_1^* = (a^*L^* - aL)/2 \\ \tilde{z}_2 = 0 & z_2 = 0 & z_2^* = (a^*L^* + aL)/2 \end{array} \tag{1.26}$$

For these production patterns to be an equilibrium, in neither country none of the idle sectors can pay higher wages that the prevailing domestic wage. This translates to[11]

$$p_1 > \tilde{a}_i \quad \text{for East} \qquad p_1 < aq_1 \quad \text{for South} \qquad p_1 < a^*q_i \quad \text{for North}$$

where q_i are the respective prices for the inputs z_i.
To rewrite these conditions in terms of productivities, start by considering the labor market of East. With the $\tilde{a}_i$ small enough, the condition for East holds always. Now, as East's labor force is assumed to be very large, $\tilde{L}_1$ is determined by the condition $p_1 = (\bar{Y}/\bar{X}_1)^{1/\varepsilon} = (B^{\varepsilon-1} + 1)^{1/(\varepsilon-1)}$ (where variables with an upper bar indicate world aggregates). These conditions give

$$\tilde{L}_1 = (aL + a^*L^*)2^{1/(\varepsilon-1)}/B^{\varepsilon} \tag{1.27}$$

The condition for South to specialize on z_1 becomes with (1.26), (1.27) and $p_1/q_1 = (\bar{X}_1/\bar{z}_1)^{1/\varepsilon}$

$$B/2^{1/(\varepsilon-1)} < a \tag{1.28}$$

Finally, note that North exits the z_1-sector if only if $q_1 < q_2$ or equivalently $\bar{z}_1 > \bar{z}_2$ for the aggregate output levels $\bar{z}_i$. But this is not possible since $a^*L^* > aL$ was assumed and the newcomer East does not produce the z_i at all. So $q_1 = q_2$ and $\bar{z}_1 = \bar{z}_2$ must hold.
This proves that the allocation pattern of (1.26) together with the according prices constitute an equilibrium, provided condition (1.28) holds.

Combining conditions (1.25) and (1.28) - and adding the condition that South does not engage in z_1-production under autarky - one summarizes the relevant range for a as

$$B/2^{1/(\varepsilon-1)} < a < \min\{(a^*L^*/2L)^{1/\varepsilon}, B\} \tag{1.29}$$

If these conditions hold at the date of East's integration in the world economy, the production patter (1.26) establishes. The first inequality implies that

[11] I disregard knife-edge cases here.

East's trade integration gives South a "push up" the production ladder and makes South specialize on z_1. The second inequality tells that South did not produce z_1 before East's integration and grew only moderately under bilaterally free trade with North nor did it engage in z_1-production under autarky.
All conditions together imply that in order for South to specialize in a high-growth good, trade with both partners, North and East is necessary.

Thus, for intermediate ranges of a (defined by (1.29)), the consequences of East's economic integration on South' income are twofold. First, there is an adverse and immediate level effect and second, there is a positive growth effect. Consider first the level effect, which appears on impact of East's accession. With (1.4) one quickly checks that South' and North' wages before the integration of East are

$$\begin{aligned} w_o &= \left(1 + 2(a^* L^*/2L)^{1-1/\varepsilon}\right)^{1/(\varepsilon-1)} \\ w_o^* &= a^* \left((2L/a^* L^*)^{1-1/\varepsilon} + 2\right)^{1/(\varepsilon-1)} \end{aligned}$$

while immediately after it they are

$$\begin{aligned} w_1 &= a\left(2(1 + B^{1-\varepsilon})\right)^{1/(\varepsilon-1)} \\ w_1^* &= a^*\left(2(1 + B^{1-\varepsilon})\right)^{1/(\varepsilon-1)} \end{aligned} \tag{1.30}$$

With the inequalities (1.29) it is quick to see that $w_o > w_1$, i.e. that wage drops in South as a consequence of the accession of large newcomer, while North wage rises unambiguously: $w_o^* < w_1^*$. This constitutes the level effect. The second effect is a growth effect. Notice that on impact of East's accession, South experiences a complete structural change, stops producing X_1, and fully specializes on z_1 instead. So South' productivity in the z_1-sector starts to grow at the rate μ (remember (1.19)). At the same time, North diversifies, producing z_1 and z_2. Consequently, by (1.19) and (1.26), North' productivity growth is biased towards the z_2-sector and North gradually shifts labor from the z_1-sector to the z_2-sector until it completely specializes on z_2.

Use (1.4) and conditions $q_1/q_2 = a_2^*/a_1^*$ and $p_1 = (B^{\varepsilon-1} + 1)^{1/(\varepsilon-1)}$ to find that[12]

$$q_1 = \left(\frac{(1 + (a_2^*/a_1^*)^{\varepsilon-1})}{(1 + 1/B^{\varepsilon-1})}\right)^{1/(\varepsilon-1)}$$

[12] One needs to reintroduce the indices for North' productivities a_i^* again, since unequal growth makes them cease to be identical.

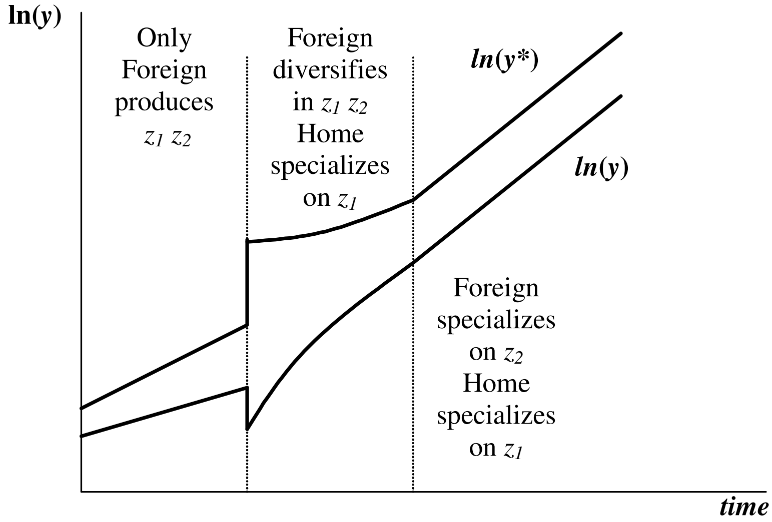

Figure 1.3: Economic Integration and the "Push Up"

Then $w = a_1 q_1$ and $w^* = a_2^* q_2 = a_2^*(q_1 a_1^*/a_2^*)$ imply the growth rates of incomes

$$\begin{aligned} g &= \dot{a}/a + \tfrac{1}{\varepsilon-1}\tfrac{d}{dt}\ln(1+(a_2^*/a_1^*)^{\varepsilon-1}) > \mu \\ g^* &= \dot{a}_2^*/a_2^* + \tfrac{1}{\varepsilon-1}\tfrac{d}{dt}\ln\left(1+(a_1^*/a_2^*)^{\varepsilon-1}\right) < \mu \end{aligned} \tag{1.31}$$

After North' structural change is completed, the wages in both countries grow at the same rates $g = g^* = \mu$.

Figure 1.3 illustrates these dynamics. It shows that for South the initial drop in income is followed by extraordinarily high growth ($g > \mu$), which sets back to lower levels after North' structural change is completed. The fact that South' income growth is temporarily extremely high stems from forces. First, complete specialization renders maximal productivity growth in South ($\dot{a}/a = \mu$); and since North is gradually retreating from z_1-production and East increases its supply of X_1, this maximal productivity growth does not lead to decreasing returns but translates into pure income growth. This explains the first term of South' growth rate in (1.31). But a second effect comes on top, which is due to the endogenous change of North' comparative

advantage. As North partly retreats from z_1-production, its productivity growth is biased towards the z_2-sector. In fact, North not only moves out of z_1-production because its comparative advantage moves against the z_1-sector but conversely its comparative advantage moves against the z_1-sector precisely because North is moving out of it. This makes North retreating from z_1-production at an even faster pace. The additional force makes South' terms of trade appreciate and translates into even higher growth in South and explains the second term in (1.31). (The same mechanism affects North' growth rate adversely.) In sum, while South can increase the productivity of its export good faster than any other country, it does not run into decreasing return to scale but experiences even an appreciation of its terms of trade.
Finally, note that when East's structural change is complete, South and North experience the same setback in growth rates, which was already discussed in section 2.

Before going on, take a closer look at the two effects that drive the growth rate in South to exceptionally high levels during the period of North' structural change. The first effect is well known. Quite generally, a country benefits the more from international trade the better it can avoid decreasing returns to output of the sectors it has a comparative advantage in. In a Heckscher-Ohlin framework with constant total factor productivity and capital accumulation Ventura [1997] shows that growth miracles can occur when countries avoid decreasing returns to capital accumulation by shifting production to goods of higher capital intensity. In the present model, South essentially avoids decreasing returns to knowledge accumulation by East's willingness to increase supply X_1 along with South' productivity growth.
Yet the second effect is unique to the Ricardian model. When the endogenous change of a country's productivities accelerates its exit from a certain sector, the one trading partner that actually takes over this sector enjoys an appreciation of its terms of trade. This gives the latter an extra boost for its growth rates[13].

Finally, a complete discussion of the "competition among developing countries" in this three-country model needs to assess the effects of South' pres-

[13]It is interesting to observe that in the Heckscher-Ohlin world, structural changes are a natural result of capital accumulation and are therefore associated with economic growth. In contrast, in the present Ricardian model, where the accumulable factor, knowledge, is sector-specific specialization is associated with high growth rates and structural changes tend to induce losses in income growth.

ence on East's growth. The dynamics of East's income is essentially the same as South' in the subsection 1.2.2[14]. But South' membership in this free trade area does affect East in two ways. First, with South producing the input good z_1, the demand of East's exports, $\tilde{X}_1$, is higher. Thus, the transition period East experiences is shorter and it's period of growth sets in earlier. The second reason is a growth effect. By assumption (1.19), there are increasing returns to specialization. Since South completely specializes in the z_1-production and thereby makes North specialize completely on z_2 within finite time, it enhances output growth in the z_i-sectors, and growth of East's terms of trade. By each of these effects, the newcomer's economic growth and welfare is unambiguously higher when its "low-wage competitor" takes part in the free trade area. The key assumption is here again that South is moving up the production ladder at the entrance on East and therefore essentially stops being a competitor of East but is rather an attractive trade partner.

In sum, the competition among developing countries is beneficial for each of them - given that (1.29) holds and provided that South discounts only mildly its future gains. In a setting that describes firms as perfectly competitive the positive impact of increased competition among less developed countries on the on their respective income is remarkable.

1.3.2 Leapfrogging

Not enough that the less developed country benefits in terms of long run growth from the accession of the newcomer, this subsection shall show that South can in fact take over the leading position is this three-country world economy and leapfrog the initial leader, North.

Figure 1.4 illustrates such a case. As explained in the previous subsection, South grows faster than North during the period in which North diversifies and produces both of the z_i goods. This is because first, South completely specializes and second, its terms of trade appreciates as North gradually retreats from production of South' export good. After that period, both countries grow at the same pace. Thus, the longer North' transition period,

[14] One could also extend the model to an equivalent of sebsection 2.3 without major difficulties by further differentiating the high-tech sector z_i with $i = 1, 2, 3,$. In such a setting all countries eventually grow at the rate μ.

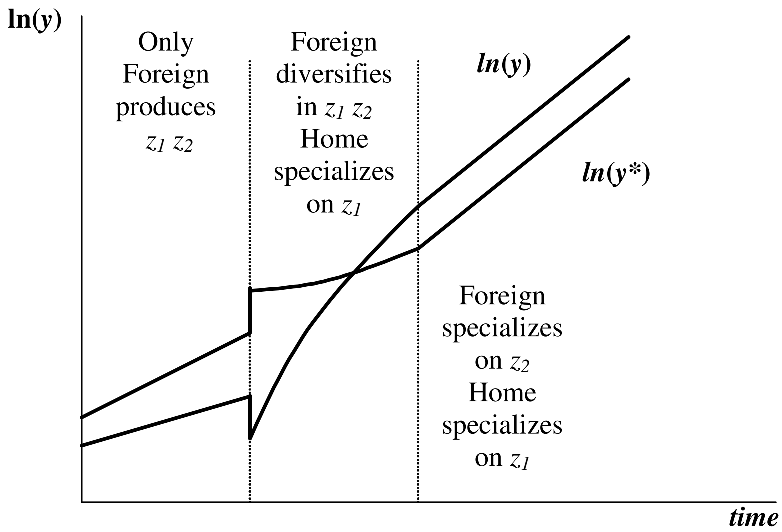

Figure 1.4: Economic Integration and Leapfrogging

the more South can catch up with North. If the period is long enough, South eventually overcomes North.

Precondition for South leapfrogging North is that the ratio of their labor forces L/L^* is relatively small. The reason for the size to play a crucial role is the following. The smaller South' labor force L, the larger must be South' productivity a in order to be able to satisfy world demand of z_1 alone - and thus the longer is the period during which North still engages in z_1-production and South' growth exceeds North'. In short, the smaller South' labor force L, the longer is its period of excess growth over North and the more likely occurs leapfrogging.

To analyze these dynamics formally, suppose that all assumptions of the previous section still hold ($a_1 = a$, $a_2 = 0$ and $a_1^* = a_2^*$ and $a_1^* L^* > aL$ at the date of East's trade integration).
Define now the fraction of North' workforce employed in input sector z_2 as λ^*. It was mentioned above that this fraction is constantly increasing and finally hits one when North' structural change is complete. This can be seen in the following way. Use $a_1^* L^* > aL$ and (1.26) to see that $\lambda^* \in (\frac{1}{2}, 1)$ at the

date of East's trade integration. Further employ $q_1/q_2 = (\bar{z}_2/\bar{z}_1)^{1/\varepsilon}$ to derive North' labor allocation during the period of its diversification:

$$\begin{aligned} L_{21}^* &= L^* \frac{a_2^*/a_1^*}{(a_2^*/a_1^*)^\varepsilon + a_2^*/a_1^*} - L \frac{a}{a_1^*} \frac{(a_2^*/a_1^*)^\varepsilon}{(a_2^*/a_1^*)^\varepsilon + a_2^*/a_1^*} \\ L_{22}^* &= \left(\tfrac{a}{a_1^*} L + L^*\right) \frac{(a_2^*/a_1^*)^\varepsilon}{(a_2^*/a_1^*)^\varepsilon + a_2^*/a_1^*} \end{aligned} \tag{1.32}$$

Together with (1.19), this leads to

$$\dot{\lambda}^*/\lambda^* = \tfrac{d}{dt}\ln(L_{22}) = \mu\lambda^* \frac{aL}{aL + a_1^* L^*} + (\varepsilon - 1)\mu(2\lambda^* - 1)\frac{(a_1^*)^{\varepsilon-1}}{(a_1^*)^{\varepsilon-1} + (a_2^*)^{\varepsilon-1}}$$

This differential equation tells that, if $\lambda^* > 1/2$, the fraction λ^* grows ($\dot{\lambda}^* > 0$). Since at the date of East's integration $\lambda^* > 1/2$ held, this means that λ^* grows and finally reaches 1: North completely specializes on z_2.

Now note that during the transition period, wages in South and North are $w = aq_1$ and $w^* = a^* q_1$. With (1.19), this means that relative incomes evolve like

$$\tfrac{d}{dt}\ln(w/w^*) = \mu\lambda^* \tag{1.33}$$

The goal is now to give a lower estimate on the ratio w/w^* at the date when North completely leaves the z_1-sector. When this date is T, and the date of East's trade integration is set to be $t = 0$, the inequality $\lambda^* > 1/2$ and equations (1.30) and (1.33) imply that at T relative incomes are

$$\frac{w(T)}{w^*(T)} = \frac{w(0)}{w^*(0)} \cdot e^{\mu \int_o^T \lambda^* dt} > a(0)/a_1^*(0) \cdot e^{\mu T/2} \tag{1.34}$$

In order to calculate the lower estimate on w/w^*, one can therefore give a lower estimate of T and plug it in the RHS. By (1.32) the transition period is characterized by

$$L^*/L \leq a(a_2^*)^{\varepsilon-1}(a_1^*)^{-\varepsilon} \tag{1.35}$$

with equality at date T. A lower bound for T is established by equalizing an upper bound of the RHS to the LHS. Since $a(t) = a(0)e^{\mu t}$, an upper bound of the RHS can be found by giving an upper bound for a_2^* and an lower bound for a_1^*. But a_2^* grows at the rate $\mu\lambda^*$, and a_1^* at the rate $\mu(1-\lambda^*)$. Some generous lower and upper bounds are therefore, respectively

$$a_1^*(t) < a_1^*(0) \cdot e^{\mu t} \qquad \text{and} \qquad a_1^*(t) > a_1^*(0)$$

Thus, the RHS of (1.35) is bounded from above by the expression

$$a(0)e^{\mu t} \cdot (a_2^*(0)e^{\mu t})^{\varepsilon-1}/(a_1^*(0))^{\varepsilon},$$

or

$$a(a_2^*)^{\varepsilon-1}(a_1^*)^{-\varepsilon} < \frac{a(0)}{a_1^*(0)}e^{\mu\varepsilon t} \tag{1.36}$$

The lower bound for date T is calculated by equating the LHS of (1.35) with the RHS of (1.36)

$$\bar{T} = \frac{1}{\varepsilon\mu}\ln\left(\frac{a_1^*(0)L^*}{a(0)L}\right)$$

This together with (1.34) and $\lambda^* > 1/2$ gives the estimate

$$w(T) > w^*(T) \cdot e^{1/2\varepsilon}L^*/L$$

These last steps lead to the following surprising finding: given that conditions (1.29) hold, trade integration with East makes South specialize in z_1-production and South *always* leapfrogs North when its labor force is relatively small compared with North', i.e. if the sufficient condition $L < e^{1/2\varepsilon}L^*$ is satisfied. Note that once North' structural change is complete, both countries' productivities grow according to (1.19) at the same rate and so does either national income. South can conserve its newly acquired leading position.

This subsection has generated a growth miracles with the help of two different effects. The first comes from avoiding decreasing returns. When a country is able to escape decreasing returns in the sector of its comparative advantage, productivity growth translates into pure income growth. The second effect comes from the dynamic change in comparative advantage due to learning by doing. When a developing country enters production of one specific sector, its incumbent producer partially shifts labor out of that sector. For the latter, this adjustment means a reduction in this sector's productivity growth and he not only retreats from the sector because the comparative advantage is moving against him, but the comparative advantage moves against him precisely because he is moving out of the sector. This amplification leads to an even faster appreciation of the developing country's terms of trade and increases its growth rate up to the point where it induces leapfrogging.

For developing countries the lesson to draw from this exercise is the following. Capturing parts of a sector with high growth potentials not necessarily makes a growth miracle. It can well be that higher productivity growth in competing countries eventually drives the developing country out of the newly entered sectors (as in section 1.2.1). Unless there exist other attractive production opportunities for the incumbent producers to shift their production to (as in sections 1.2.3, 1.3.1, and 1.3.2) a race for market shares sets in between competing countries with uncertain result. A further beneficial condition for a growth miracle to occur is the outsourcing of (low-technology) goods whose production does not exhibit learning by doing (as in section 3). In fact, this constitutes a pure infant industry argument from the winner's point of view. Finally, for a growth miracle to occur, the newly entered sector should meet a demand large enough to offer expansion in the medium run (reflected in the condition $L < e^{1/2\varepsilon}L^*$ of the present section).

This present section emphasized the beneficial effect that trade integration of a large developing economy can have on the growth performance of smaller developing countries. By freeing resources at the bottom of the product ladder these latter can enter industries with higher learning effects and growth potential. However, the immediate static level effect on the small developing countries is always negative. Whether the static welfare loss can be compensated by higher future growth then depends on the patience of the developing countries' citizens.

1.4 Conclusion

This chapter has contributed to the discussion on the channels between international trade and economic growth. It has focused on the growth performance of developing countries in the race for market shares in advanced and dynamic sectors. It thereby distinguished between first, the effects of international trade relations with industrialized countries, evaluating the infant industry reasoning and second, an increased competition among developing nations in a three-country setting.
The first part developed a simple model that puts Young's [1991] version of the infant industry argument of into a very handy framework, illustrating that for developing countries the static gains from trade may come at the cost of reduced long-run growth. In such a case trade integration hinders economic development. Yet, a small modification of the model turns around that picture and helps to identify a drawback of the infant industry argument that previous literature had overlooked. It was shown that the presence of a subsistence-technology, barriers to trade can reduce the demand for

high-technology goods such that production drops precisely in those sectors, which protectionism originally intended to promote. In that scenario, protectionism undermines industrialization and long-run growth. The underlying assumptions conversely imply that trade liberalization spurs the production of higher-technology goods in developing countries. The surge of Mexico's exports of "Advanced Technology Products" in the first decade of NAFTA up to the fivefold of their 1994 level can be understood as support for this view.

The second part extended the model to a three-country setting to address the impact of competition among developing countries on their growth performance. Some small developing countries observe with concern that large labor abundant nations like India and China integrate in the world economy. The analysis showed that trade integration of a large developing nation can push small developing economies up the product ladder into production with higher growth potential. Thus, the increased competition sets small developing countries on the track of faster economic development. While a static level effect of the increased competition is always adverse, the following boost in income growth makes small developing countries outperform industrialized economies and can even bring them to leapfrog the initial leaders. In the period of exceptionally high growth of the developing country two beneficial effects are identified. First, as competitors are moving out of production in the sector of its comparative advantage, the developing country meets constant returns while growing in one sector only. Second, this effect is amplifies by the endogenous change in comparative advantage.

Appendix Chapter 1

In the two-country model of section 1.2.1, when $L_2 < L/\varepsilon$ holds, then L_2 goes to zero in finite time. Assume that $L_2 > 0$, i.e. South diversifies, implying $p_1/p_2 = A$ The world aggregates are then $\bar{X}_1 = L - L_2$ and $\bar{X}_2 = A^* L^* + A L_2$ and (1.4) gives

$$L_2 = \frac{A^\varepsilon L - A^* L^*}{A^\varepsilon + A} \tag{A1}$$

This expression has the upper bound $L_2 < L_M := L - A^* L^* / A^\varepsilon$. By (A1), L is increasing in A and by (1.7) $\dot{A}$ is increasing in L_2. Thus, the solution to (1.7) with initial values (A1) has an upper bound by the solution to (1.7) when replacing L_2 by L_M Using $\dot{A}^*/A^* = e^{\mu t}$, the system (1.7) and $L_2 = L_M$ has a stationary solution at

$$\tfrac{d}{dt} L_M = A^* L^* / A^\varepsilon \left(\mu - \mu \varepsilon L_M / L\right) = 0$$

or $L_M = L/\varepsilon$. For initial values $L_M < L/\varepsilon$ the upper bound L_M decreases at an accelerating pace and hits zero in finite time. Thus, so does L_2.

References

Acemoglu, D. and Ventura, J. [2002]: "The World Income Distribution" *Quarterly Journal of Economics*

Baldwin, R [1969]: "The Case Against Infant-Industry Tariff Protection", *Journal of Political Economy*

Baldwin, R. [2003]: "Openness and Growth: What's the Epmirical Relationship?", NBER Working Paper No. 9578

Brezis, E. S., Krugman, P. and Tsiddon D. [1993]: "Leapfrogging in International Competition: A Theory of Cycles, and National Technological Leadership" *American Economic Review*

Brooks, R. and Ran, T. [2004]: "China's Labor Market Performance and Challenges" China & World Economy Volume 12 No.3, Institute of World Economics and Politics, Chinese Academy of Social Sciences

Ciccone A., Alcalá F. [2004]: "Trade and Productivity" *Quarterly Journal of Economics*

Ciccone, A. and Matsuyama, K. [1999]: "Efficiency and Equilibrium with Dynamic Increasing Aggregate Returns Due to Demand Complementarities" *Econometrica*

Das, S. and Srinivasan, K. [1997]: "Duration of Firms in an Infant Industry: the Case of Indian Computer Hardware", *Journal of Development Economics*

Dornbusch, R.; Fischer, S. and Samuelson P. A. [1977]: "Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods" *American Economic Review*

Dornbusch, R. [2001]: "The Case of Trade Liberalization in Developing Countries" *Journal of Economic Perspectives*

Dozin, S. and Vamvakidis, A. [2003]: "Trade and Industrialization in Developing Economies", *Journal of Development Economics*

Easterly, W and Levine, R. [2001]: "It's Not Factor Accumulation: Stylized Facts and Growth Models" World Bank

Eichengreen, B., Rhee, Y. and Tong, H. [2004]: "The Impact of China on the Exports of Other Asian Countries" NBER Working Paper No. 10768

Frankel, J. A. and Romer D. [1999]: "Does Trade Cause Growth?" *American Economic Review*

Hanson, G. [2003]: "What has Happened to Wages in Mexico Since NAFTA? Implications for Hemnispheric Free Trade" NBER Working Paper No. 9563

Harrison, A [1994]: "An Empirical Test of the Infant Industry Argument: Comment", *American Economic Review*

Harrison, A. and Hanson, G. [1999]: "Who Gains from Trade Reform? Some Remaining Puzzles" *Journal of Development Economics*

Imbs, J. and Wacziarg, R. [2003]: "Stages of Diversification" *American Economic Review*

Inter-American Development Bank (IDB): "The Emergence of China: Opportunities and Challenges for Latin America and the Caribbean", *forthcoming* March 2005

Kaneda, M. [2003]: "Policy Designs in a Dynamic Model of Infant Industry Protection", *Journal of Development Economics*

Krueger, A. and Tuncer, B. [1982]: "An Empirical Test of the Infant Industry Argument", *American Economic Review*

Krueger, A. and Tuncer, B. [1984]: "An Empirical Test of the Infant Industry Argument: Reply", *American Economic Review*

Krueger, A. and Tuncer, B. [1994]: "An Empirical Test of the Infant Industry Argument: Reply", *American Economic Review*

Krugman P. [1987]: "The Narrow Moving Band, the Dutch Disease and the Competitive Consequences of Mr. Thatcher" *Journal of Developing Economics*

Leahy, D. and Neary, P. [1999]: "Learning by Doing, Precommitment, and Infant-Industry Protection", *Review of Economic Studies*

Lee, J. [1997]: "The Maturation and Growth of Infant Industries: The Case of Korea", *World Development*

Lucas, R. [1982]: "An Empirical Test of the Infant Industry Argument: Comment", *American Economic Review*

Lucas, R. [1993]: "Making a Miracle" *Econometrica*

Luzio, E. and Greenstein, S. [1995]: "Measuring the Performance of a Protected Infant Industry: the Case of Brazilian Microcomputers", *Review of Economics and Statistics*

Matsuyama, K. [2000]: "A Ricardian Model with a Continuum of Goods under Nonhomothetic Preferences: Demand Complementarities, Income Distribution and North-South Trade," *Journal of Political Economy*

Melitz [2005]: "When and How Should Infant Industries be Protected?", forthcoming in *Journal of International Economics*

Miravete E. [1997]: "Infant-Industry Tariff Protection with Pressure Groups", *International Journal of Industrial Organization*

Miravete, E. [2003]: "Time-Consistent Protection With Learning by Doing", *European Economic Review*

Murphy, K. M.; Shleifer, A. and Vishny R. W. [1989]: "Industrialization and the Big Push" *Journal of Political Economy*

Ohyama, A.; Braguinsky, S..and Murphy, K. [2004]: "Entrepreneurial Ability and Market Selection in an Infant Industry: Evidence from the Japanese Cotton Spinning Industry", *Review of Economic Dynamics*

Romer, P. M. [1986]: "Increasing Returns and Long-Run Growth" *Journal of Political Economy*

Rodríguez, F. and Rodrik, D. [2000]: "Trade Policy and Economic Growth: A Sceptic's Guide to the Cross-National Evidence", NBER *Macroeconomic Annual*

Sachs, J. and Warner, A. [1995]:"Economic Reform and the Process of Global Integration" *Brookings Papers on Economic Activity*, No.1.

Wacziarg, R. and Wallack J. S.[2004]: "Trade Liberalization and Intersectoral Labor Movements" *Journal of International Economics*

Wacziarg, R. and Welch K. [2003]: "Trade Liberalization and Growth: New Evidence" NBER, WP 10152

Ventura, J. [1997]: "Growth and Interdependence" *Quarterly Journal of Economics*

Young, A. [1991]: "Learning by Doing and the Dynamic Effects of International Trade", *Quarterly Journal of Economics*

Chapter 2

How to Use Subsidies to Sustain Trade Agreements

Abstract: With the help of a simple Ricardian model, this chapter explores the role of subsidies in self-enforcing trade agreements. A first part shows that the optimal self-enforcing trade agreement includes subsidies to inefficient, import-competing sectors. When - by some exogenous or endogenous force - comparative advantage deepens, declining industries are optimally subsidized. Key assumptions driving these results are: essentiality of imported goods and a high flexibility of the countries' industrial structure. A final part relaxes the second assumption and shows that under rigid industrial structure subsidizing import competing sectors can actually destabilize trade agreements.

2.1 Introduction

The dramatic trade liberalization in recent decades notwithstanding, governments all over the globe continue to spend huge sums to promote comparatively disadvantage and declining industries. While policymakers like to justify such actions by appealing to the strategic value of the industries in question, economists, concerned about efficiency, tend to discard these claims and blame these same policies for incurring deadweight losses. The present chapter argues that protection of inefficient and declining sectors can after all be welfare improving. It shows that subsidizing constitutes an efficient way to make countries respect trade agreements and is therefore part of optimal trade agreements.

To frame the case, a two-country model of repeated trade is developed. Key to the model is the self-enforcement requirement, which international agreements have to satisfy. It reflects the assumption that sovereign countries cannot be forced into international cooperation but will respect only those agreements that appear beneficial to them. But it is well known that large countries have an incentive to cheat on free trade agreements by unilaterally erecting trade barriers, thereby collecting gains via improved terms of trade. The only way to keep countries from doing so is the credible threat of punishment following such unilateral defections. A trade war with uncooperative actions from all countries constitutes such a credible punishment. Forward-looking governments weigh the transitional gains from defection against future losses from trade war. Trade agreements, which all members voluntarily choose to respect are said to be self-enforcing.
Yet when temptation to defect on free trade grows too strong, free trade ceases to be self-enforcing. What brings remedy in such situations? It is well understood that countries can use trade barriers in order to reduce foreign defection incentives. Previous literature has focused on the use of tariffs as such instruments. This chapter analyzes the situation when governments can set, in addition to tariffs, subsidies to reduce foreign defection incentives. Optimal trade agreements will implement an efficient mix of both. It is shown that when imported goods are essential, subsidies are always part of the constrained optimal trade agreement. For the intuition of this finding, notice that the more a country looses from hostile foreign trade policy, the more a defecting trade partner can gain - and the stronger are temptations to defect. The importer's vulnerability and the exporter's incentive to cheat are two sides of the same coin. A country that imports an essential good is particularly vulnerable to foreign defection, so in order to reduce foreign defection incentives it chooses not to rely entirely on imports but produces some of the essential good at home. Since finally local production is not internationally competitive it requires subsidies.

A first extension of the model introduces a simple form of learning by doing within sectors and provides a rationale for the protection of declining industries. The extension starts from the above statement that subsidies to import-competing sectors are part of optimal trade agreements. When the pattern of comparative advantage deepens, the value of cooperation increases relative to the value of defection and the self-enforcement constraint is relaxed. This leads to a reduction of tariffs and subsidies. The liberalization is gradual, since anticipated *future* gains from cooperation relax the *present*'s self-enforcement constraint and allow a partial liberalization today already. Thus, during the liberalization process, initially protected sectors slowly shrink due to less and less protection. The reason for such gradual liberalization does not come from the desire to cushion incomes or avoid political resistance - it is an optimal policy to run along the path of a binding self-enforcement constraint.

A second extension severely qualifies and partially reverses the basic findings. It introduces rigidities in industrial structure, considering a world where production capacities take time to build and output patterns are slow to change, such that countries very much depend on imports even after trade agreements break down. This implies that any defection is followed by a particularly tough trade war. By increasing the punishment that follows defection, mutual dependence now proves to be beneficial. In fact, the deliberate creation of dependence constitutes a way to commit to free trade, making free trade more likely to be self-enforceable. In this scenario, subsidies to import competing sectors can undermine the commitment device and make cooperation harder.

Up to very recently, economic theory has widely neglected the role of subsidies in trade agreements, in spite of their prominent role in international trade negotiations. Motivated by the strict standing of the WTO on subsidies, Bagwell and Staiger [2004] address this issue for the first time and conclude that the ban on all (but agricultural) subsidies may go too far and the "WTO subsidy rules may ultimately do more harm than good to the multilateral trading system". The present chapter analyzes subsidies in the context of self-enforcing trade agreements and conditionally confirms this finding, specifying some assumptions under which it holds. It further shows that protection optimally favors comparatively disadvantaged sectors, which is widely consistent with empirical work on protection and trade policy: Lee and Swagel [1997] write that "nations tend to protect industries that are weak, in decline, [...] or threatened by import competition". Trefler's [1993] estimates show that a higher import penetration is associated with greater protection, and Goldberg and Maggi [1999] find that "within the group of non-organized sectors, protection tends to increase with import penetration". In the theory of trade agreements, protectionism is typically explained by political economy arguments. Rodrik [1995] provides an overview of this litera-

ture. He claims, however, that "we lack a good explanation of the universal preference for trade restricting policies over trade promoting ones". Political economy has had difficulties in justifying this anti-trade bias in trade policies; previous explanations addressing the issue are scarce and rely on rather specific assumptions (see Limao and Panagariya [2002] and Fernandez and Rodrik [1991]). The present work takes a different route and argues that an anti-trade bias may be precisely what welfare-maximizing governments optimally do to make trade agreements self-enforcing.
The final extension, which introduces frictions to output adjustment, carries the flavor of Furusawa and Lai [1999] who find that the costs of adjusting output structures tend to relax the self-enforcement constraint because of increased costs of returning to non-cooperation.
Finally, the present work relies on Dixit [1987], who introduces self-enforcing agreements to the literature of trade theory. The model's formal structure follows Devereux [1997] who in turn strongly builds on Kennan and Riezman [1988].

The remainder of the chapter contains five sections. Section 2 develops the basic model of non-cooperative trade. Section 3 then considers repeated trade and cooperative behavior, highlights the role of the self-enforcement constraint, and presents the basic finding. Section 4 introduces learning by doing to explain gradualism and the protection of declining industries. Section 5 introduces rigidities in the industrial structure of the countries and discusses the consequences. Finally, section 6 concludes.

2.2 The Basic Model

There are two countries, Home and Foreign (Foreign variables denoted by *), who produce two goods x and y with constant returns to scale technologies using one single factor, labor. Countries have equal size of labor force, normalized to unity: $L = L^* = 1$. Assume that Home's (Foreign's) productivity in x- (y-) production equals b while its productivity in the y- (x-) production is equal to 1. With $b > 1$, this means that Home is the natural exporter of x. Technologies are disembodied and, for a start, exogenous:

$$x = bL_x \qquad y = L_y \qquad\qquad x^* = L_x^* \qquad y^* = bL^* \tag{2.1}$$

At each date, consumers enjoy the momentary utility (simply called utility in the following) of Cobb-Douglas type and symmetric in the two goods:

$$u(c_x, c_y) = \sqrt{c_x c_y} \tag{2.2}$$

To save notation, here and whenever there is no risk of confusion, time indices are dropped.

There is no capital and no savings decision such that, at every point in time, individuals simply maximize utility (2.2) subject to their budget constraint. Markets are competitive and only subject to distortions from government policies specified below.

The economy described here is completely symmetric and the analysis will be restricted to symmetric outcomes throughout the chapter.

2.2.1 The Integrated Economy and Free Trade

The integrated economy is a world where goods and factors can cross borders without costs. By symmetry, in such a world the relative price of goods is one ($p_x/p_y = 1$). All goods are produced competitively using the most efficient technology available, i.e. productivity in both sectors is b. Individuals face the budget constraint $c_x + c_y \leq I = b$, which implies that utility of a representative consumer in either of the two countries is

$$u^F = b/2 \tag{2.3}$$

This utility reflects the efficient outcome of the integrated economy. This outcome is also attained in a world where trade in goods is free and costless but factors - that is labor - is bound to stay within national borders. In this world of free trade there is complete international specialization, relative goods price is unity, and the citizens' utility is (2.3) again.

Yet, countries have an incentive to distort the world economy by erecting trade barriers and thereby manipulate the terms of trade to their favor. This will be discussed next.

2.2.2 Trade War

When two large countries cannot commit to free trade, they will try to manipulate the terms of trade to their favor. This results in a trade war with typically all sides loosing - the tariff setting game is subject to a prisoner's dilemma. In this respect, the symmetric model is no exception: the net effects of the terms of trade manipulation cancel out and the world economy is left with the distortions only.

When analyzing the strategic behavior of countries within the trade game, it is necessary to be more specific about the structure of the economy. Each country hosts consumers, firms and a government. Consumers and firms are atomistic and do not act strategically in any respect. Governments, on the other hand, can set ad valorem import tariffs and production subsidies. The gross import tariffs T and T^* drive a wedge between local and international prices of the imported goods. Throughout the chapter, the world price of good x will be normalized to one while the world price of good y is denoted by p. This means that local prices are $p_x^{Home} = 1$, $p_y^{Home} = Tp$ and $p_x^{Foreign} = T^*$, $p_x^{Foreign} = p$. Subsidies can go to one or both sectors in each country. They constitute a monetary reward distributed to producers. To be precise, governments hand out per-unit subsidies to domestic producers within a given sector up to a targeted quantity, such that domestic firms produce a minimum amount of output within the specific sector, independent of current market prices[1]. The budget is financed by lump-sum taxes. Governments choose both of their policies strategically, tariffs and minimum domestic output of the sector. Consumers, firms, and governments are assumed to take actions simultaneously, maximizing their respective objective.

Consumers maximize utility (2.2). When tariff revenues are distributed lump sum to citizens, average income in Home is $I = x + pTy + (T-1)p(c_y - y)$. Expenditure shares are constant and one half ($pTc_y = c_x = I/2$) such that Home's income is $I = (x + py)2T/(T+1)$ and Home's utility

$$u = \frac{x+py}{\sqrt{p}} \cdot \frac{\sqrt{T}}{T+1} \tag{2.4}$$

Note that in the case of symmetry $p = 1$ and $u = (b(1-y)+y)\sqrt{T}/(T+1)$. This equation reveals the two sources of inefficiencies: tariffs and production distortions. Optimal are zero import tariffs ($T = 1$) and complete specialization ($y = 0$, $x = b$), which makes (2.4) equal to (2.3) - but as will become clear shortly neither will hold under uncooperative, i.e. Nash strategies.

[1]Supposing an utilitarian welfare function, governments are indifferent about income distribution and can set subsidies high enough to leave the subsidized firms production decision unaffected by price changes.

Calculations parallel to the ones that lead to (2.4) give Foreign's income and consumption pattern. With the trade balance $x - c_x = p(c_y - y)$ one solves for the world price for good y

$$p = \frac{x^* T^*(T+1) + x(T^*+1)}{yT(T^*+1) + y^*(T+1)} \tag{2.5}$$

Firms maximize profits while taking prices, tariffs and subsidies (i.e. minimum output quantities) as given. Thus, output in Home is

$$y \in \begin{cases} \{\bar{y}\} & if\ pT < b \\ [\bar{y}, 1 - \frac{\bar{x}}{b}] & if\ pT = b \\ \{1 - \frac{\bar{x}}{b}\} & if\ pT > b \end{cases} \qquad x \in \begin{cases} \{b(1-\bar{y})\} & if\ pT < b \\ [\bar{x}, b(1-\bar{y})] & if\ pT = b \\ \{\bar{x}\} & if\ pT > b \end{cases} \tag{2.6}$$

where $\bar{y}$ and $\bar{x}$ are the minimum domestic output levels, the government in Home induces through subsidies.

Government are assumed to be benevolent-nationalistic and engage in tariffs and subsidies to increase their citizens' utility (2.2). The next step will determine such individually optimal policies.

When Home's government engages in subsidy and tariff setting, it takes into account firms behavior (2.6) (and Foreign's equivalents) and the domestic consumers' choices (2.4). So the uncooperative, static maximization problem is[2]

$$\max_{T,\bar{x},\bar{y}} \frac{x + py}{\sqrt{p}} \cdot \frac{\sqrt{T}}{T+1} \qquad s.t.\ (2.6) \text{ and Foreign's equivalent and } (2.5) \tag{2.7}$$

while Foreign's policy functions T^*, $\bar{x}^*$, and $\bar{y}^*$ are treated as constants. The optimality condition for the tariffs gives rise to the best response functions[3]

$$T(T^*) = \sqrt{\frac{y^*}{x^*} \cdot \frac{x^* + x(1 + 1/T^*)}{y^* + y(T^*+1)}} \tag{2.8}$$

Under symmetry, the best response function leads to the Nash strategies

$$T^N = T^{*N} = \sqrt{x/y} \tag{2.9}$$

[2]The resource constraint $x = b(1-y)$ and the non-negativity constraints are suppressed here.

[3]See Appendix I.

Appendix I shows that optimality of subsidies and (2.9) lead to

$$\begin{array}{lll} \bar{y}^N = 1/(b+1) & \bar{x}^N = 0 & T^N = b \\ \bar{x}^{*N} = 1/(b+1) & \bar{y}^{*N} = 0 & T^{*N} = b \end{array} \tag{2.10}$$

Together, the Nash strategies (2.10) and utility (2.4) give

$$u^N = \frac{b^2+1}{b+1}\sqrt{b} \tag{2.11}$$

This is the utility of citizens living in a world where governments non-cooperatively choose import tariffs, exploiting their market power in the world market. This market power is smaller, the less foreigners are vulnerable to domestic tariff setting; and in order to be less exposed to tariffs, foreigners produce part of the import-good on their own. Tariffs are thus identified as the aggressive part of the trade war by which countries try to change the terms of trade and extract gains, while subsidizing is a defensive move that shields countries from foreign tariffs. Both policies distort the economy and induce efficiency losses.
This section has shown that countries engage in distorting policies to improve their terms of trade and how these attempts mutually neutralize, creating losses for all. The trade game is subject to a prisoners' dilemma and as such its inefficiencies can be cured through reputation building in a repeated game. Infinite repetition of the stage game described above is dealt with in the next section.

2.3 Repeated Trade and Cooperation

The last section has shown that in a one-shot trade game countries are tempted to reap gains by charging tariffs unilaterally. In a repeated game, such actions can be prevented when they come at the cost of future cooperation. Following standard assumptions, transitional gains from defection are supposed be followed by a breakdown of trust and future cooperation. If the threat from future trade war is severe enough, free trade is dynamically optimal or self-enforcing. However, if countries heavily discount future utility, this is not the case. In such a situation, it is possible to sustain *some*, though not *complete* liberalization of trade. It is then necessary to analyze which of the trade barriers are preferably to be removed and which should stay to keep agreements self-enforcing. This section explores the mix of the two policy instruments - tariffs and subsidies - that is appropriate to make trade agreements sustainable in a setting of repeated trade games. The next subsection prepares the ground and illustrates the conditions under which free trade is self-enforcing.

2.3.1 Sustaining Free Trade

Assume that the stage game of the previous section is repeated infinitely often. Let β be the factor the two countries discount the flow-utilities (2.2) with. Now, consider the following "trigger strategies" in order to sustain free trade: both countries set neither tariffs nor subsidies ($T = T^{*} = 1$ and $\bar{y} = \bar{x}^{*} = 0$) as long as both did so in every period in the past. Yet, if one country defects and deviates the other cannot react in the same period - but cooperation breaks down and both countries play Nash strategies ever after, receiving utility (2.11).

Before proceeding, it is necessary to carefully define the events which occur under defection. As outlined in the previous section, firms produce while taking prices and subsidies as given. If now a government defects on a trade agreement, it potentially deviates in both, tariffs and subsidies. This deviation hits all other agents in the world economy - including local and foreign firms - by surprise. In particular, firms are unable to adjust output capacities such that output patterns of the defection period remain unaffected. Since they do not impact actual production patterns, changes in subsidies can be safely neglected in the analysis of defection. Thus, the optimal deviation from a trade agreement will be thought of as an unilateral raising of tariffs according to the best response function (2.8) while output patterns are held fix at cooperation levels.

Whether cooperation or defection will prevail depends on the respective payoffs. Cooperation is said to be self-enforcing if the future discounted flow of utility under cooperation is bigger than that of defection:

$$V^{Cooperate} = \sum_{t \geq 0} \beta^{t} u_{t}^{C} \geq u_{0}^{D} + \sum_{t \geq 1} \beta^{t} u_{t}^{N} = V^{Defect} \tag{2.12}$$

Equation (2.12) is called the self-enforcement constraint (SEC) and plays a central role in the following analysis. In the expression u^{C} stands for the cooperation utility, u^{N} for the Nash utility (2.11), and u^{D} for defection utility.

The main tasks will be to explore when it binds and how to use tariffs and subsidies optimally to make it hold. Note that in a time-invariant setting it can be written as

$$\beta \geq \frac{u^D - u^C}{u^D - u^N} \tag{2.13}$$

To see whether free trade is self-enforceable, collect the respective utilities in (2.13). Under free trade, cooperation utility is $u^C = b/2$ and the Nash utility is (2.11). Defection on free trade means that one country set tariffs according to the best response tariffs (2.8) while output patterns are $(x, y) = (y^*, x^*) = (b, 0)$. This leads to a defection utility of $u^D = b/\sqrt{2}$ and free trade is self-enforceable whenever

$$\beta \geq \frac{\sqrt{2} - 1}{\sqrt{2} - 2u^N/b} = \beta^{FT} \tag{2.14}$$

Note with (2.11) that $\beta^{FT}(b)$ is decreasing in b. As the differences in productivity grow larger, the more likely free trade is sustainable, because an increase in b makes the value of cooperation grow faster than the value of defection. To see why, notice that an increase in b improves the production possibilities but also increases the relative dependence, which makes the trade war tougher and tends to reduce trade war utility. The overall benefits of an increase in b on trade war utility is therefore less than its impact on cooperation utility. Now, as the value of defection is a composite of the instantaneous gains and the trade war consequences, the increase in b increases cooperation value more than the defection value and thereby relaxes the self-enforcement constraint. This mechanism will play a central role in section 4.

Whenever countries heavily discount future utility, condition (2.14) is violated - the threat of a trade war is not enough to sustain free trade. For the remainder of the chapter this will be assumed to be the case [4]. Now it is well understood that when free trade is not self-enforcing, it is possible to sustain some, tough not complete trade liberalization. In the present framework where two policy instruments - tariffs and subsidies - are available the natural question arises which of them should be reduced to what extend. This question will be addressed next.

[4] Seeking remedy from this inefficiency, some scholars follow Dixit (1987) and assume autarky as a harsher threat. While this makes cooperation on free trade more likely it obviously does not guarantee it. The results in the following do not depend on the choice of (2.11) as the threat.

2.3.2 Sustaining Agreements through Protection

Assume that countries are impatient and free trade is not self-enforcing. Then, starting from the trade war level, a *partial* reduction of tariffs and subsidies is still self-enforcing. The idea is to keep positive amounts of trade barriers to reduce incentives to defect and thus make cooperation possible[5]. The inefficiencies these policies create are the price to pay for avoiding larger losses of a trade war. To calculate the optimal policies, call the tariff and subsidies implemented by an agreement $\bar{y}^A$, $\bar{x}^A$, and T^A. The optimal symmetric self-enforcing trade agreement is then the solution of

$$\max_{\bar{y}^A,\bar{x}^A,T^A} u(\bar{y}^A,\bar{x}^A,T^A) \qquad s.t.\ \beta \geq \frac{u^D(\bar{y}^A,\bar{x}^A,T^A) - u^C(\bar{y}^A,\bar{x}^A,T^A)}{u^D(\bar{y}^A,\bar{x}^A,T^A) - u^N} \tag{2.15}$$

Note that the quantity $\bar{y}^A$ ($\bar{x}^A$) describe both countries' subsidized output levels of the respective import (export) sector. Cooperation utility is $u^C = (\bar{x}^A + \bar{y}^A)\sqrt{T^A}/(T^A+1)$ according to (2.4), u^N is from (2.11) and u^D is the defection utility. The arguments of u^D are the cooperation policies that are defected on; the actual defection tariff is defined by equation (2.8) while output patterns are the cooperative ones. By symmetry, the solution of (2.15) maximizes both countries' utility. Both countries also face the same self-enforcement constraint such that (2.15) entirely defines the symmetric problem. The efficient trade agreement is described by the optimal policy functions $(\bar{y}^A,\bar{x}^A,T^A)$ that solve (2.15).

As discussed above, the solution to this problem is no intervention at all provided that the discount factor β is large enough - i.e. the self-enforcement constraint does not bind. If $\beta = 0$, on the other hand, the future is not valued at all and the outcome is a trade war as in section 2. For any intermediate range of β, the self-enforcement constraint does bind and one can show that[6] $\bar{y}^A > 0$, $\bar{x}^A = 0$ and $T^A > 1$. In particular, one can formulate the following

Proposition 1 *In the economy described in Section 2, any symmetric self-enforcing optimal trade agreement that does not implement free trade includes*

[5] The reason for this general result is that small deviations of the policy functions around the Nash levels have a first-order impact on the cooperation utility but only a second order effect on the defection utility.

[6] Strictly speaking, governments are indifferent in giving subsidies to the exporting sector up to the optimal level. However, a negligible but positive cost of subsidizing would prevent this.

subsidies favoring import competitors. The lower the discount factor, the higher are these subsidies.

Proof. See Appendix. ■

Figure 2.1 illustrates the finding of the proposition. On the horizontal axis of the top panel, the discount factor β runs from zero to one. For large β, inequality (2.14) is satisfied and free trade is sustainable. Consequently, no tariffs are charged and there is no import competing production under the optimal trade agreement. As soon as β drops below the threshold in (2.14) the optimal trade agreement includes positive y-production. As the discount factor approaches zero countries ignore future benefits, the only reason for respecting the agreements disappears and the optimal trade policies $(\bar{y}^A, T^A)$ approach the Nash levels (2.10).

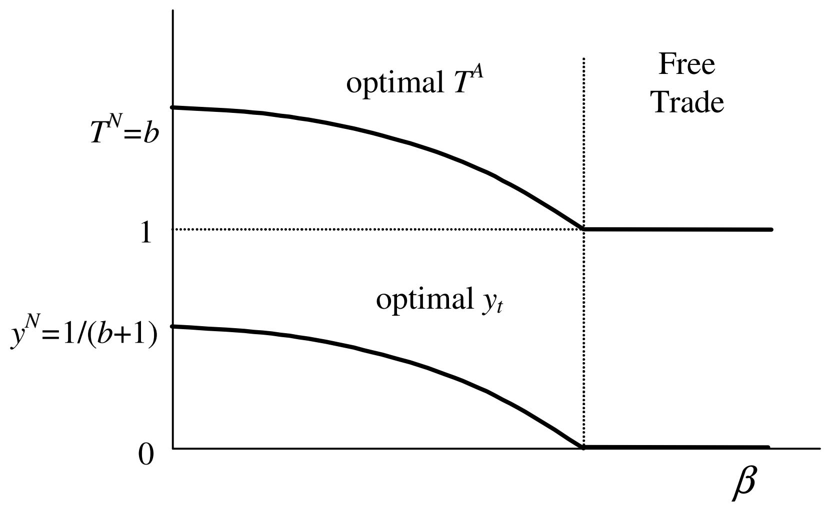

Figure 2.1: Optimal Trade Agreements

For an intuition of Proposition 1, assume that, say, Home does not produce its import good y at all. As Foreign is the only supplier of the essential y, Home strongly depends on Foreign supplies and Foreign's potential gains from defection are large. But already small amounts of y-production in Home break the Foreign's monopoly position and dramatically reduce its ability to extract output from Home. Thus, positive domestic production of the imported good is part of any trade agreement that does not implement free trade. But why do domestic markets fail to provide the optimal quantity $\bar{y}^A > 0$? Somewhat paradoxically, domestic prices of import goods are below the threshold that would induces local production precisely because trade agreements are respected. At the same time, the agreement is respected only because local production is held at positive levels. In this situation, a decentralized market surely fails to provide the optimal production level and the government must step in and subsidize import-competing production.

For a deeper understanding of Proposition 1 recall that the situation in a tariff game with competitive firms is roughly the following: the countries' governments - not caring about foreign consumers' losses but well about domestic producers' gains - try to replicate monopoly markups on the countries exports and set tariffs to this end. Monopoly markups, however, depend on the elasticity of demand σ by the factor $1/(\sigma - 1)$. Now, by engaging in production of the import good, a country *increases* its import elasticity. Thus, it reduces foreign market power and thereby the surplus foreigners can extract when defecting - foreign incentives to defect fall. Since the Cobb-Douglas utility has an elasticity of substitution of one, the elasticity of import demand σ is equal to one whenever there is no production of the imported good. In that situation the markup $1/(\sigma - 1)$ is unbounded. Yet, producing small amounts of the import-good domestically increases import elasticity somewhat but reduces the defector's markup dramatically. Therefore, import competing production is extremely efficient in reducing the defection utility and part of trade optimal agreements.

Proposition 1 states that subsidies can be efficient in reducing vulnerability to unreliable suppliers. Some aspects of the energy crisis of 1973 can be reread in the light of that finding: when the OPEC imposed an embargo on western industrialized countries, these latter spent huge subsidies to set up national energy programs. The stated aim was to reach some degree of self-sufficiency and reduce the vulnerability to the countries that just had demonstrated their ability to collude to a cartel of suppliers. This behavior obviously carries the flavor of Proposition 1. But, more surprisingly, continued and even intensified these programs after international oil prices dropped in the counter-oil shock 1986 (see Kohl [1991]). Even that can be justifies by Proposition 1. Although a common objection to such politics is that energy reserves are not to be depleted in times of low international prices but should rather be preserved for periods when world markets are tighter. The model shows that subsidized energy production might precisely prevent such a renewed tightening of import supply by cutting the incentives of oil-producers to collude. The key observation here is that supply shortages are endogenous and can be prevented by artificial domestic competition. Thus, the seemingly lobby-oriented policy may eventually have been socially optimal.

Before closing this section, it is instructive to look at the consequences of impeding *any* kind of subsidies. In fact, the WTO's [1995] legislation comes close to a complete ban of subsidies and Bagwell and Staiger [2004] raise the important question about efficiency of such a rule.
Assume therefore that governments have no policy instrument apart from import tariffs. This implies that import competing production is zero as soon as symmetric tariffs are below the (Nash) level $T = b$. Consider now a trade agreement inducing the tariff $T^A < b$. Equations (2.5) and (2.8) imply $pT^D \to T^A + 1$ such that $u^D(T^A) = b/\sqrt{T^A + 1}$. Cooperation utility is $u^C(T^A) = b\sqrt{T^A}/(T^A + 1)$, and trade war utility is u^N from (2.11). Then, for the trade agreement to be self enforcing, (2.13) requires the discount factor β to exceed the minimum level of[7]

$$\beta^M(b) = \min_{T^A \in [1,b]} \left\{ 1 - \frac{u^C(T^A) - u^N}{u^D(T^A) - u^N} \right\} > 0 \qquad (2.16)$$

This leads to the following

Remark to Proposition 1 *If countries cannot engage in subsidies, any discount factor that falls short of β^M as defined in (2.16) leads to a trade war.*

The remark highlights the importance of subsidies for trade agreements. Countries living in such a world where future gains are heavily discounted would turn down the possibility to join a trade agreement that bans all kinds of subsidies, fearing defection of foreigners.
In a somewhat different setting, Bagwell and Staiger [2004] analyze the consequences of the WTO's ban of a wide range of subsidies (WTO [1995]) and conclude that these strict rules "may ultimately do more harm than good to the multilateral trading system". Proposition 1 supports this view. Remark goes further and stresses the potential importance of subsidies in trade

[7] It is quick to check that the strict inequality holds.

agreements by showing that a ban of subsidies may actually prevent any efficiency-enhancing agreement.

This section has made a case for the protection of import competing sectors through subsidies and tariffs. Rodrik [1995] identifies an "anti-trade bias" in trade policy, in the sense that policy instruments typically tend to hinder rather than to promote world trade flows. Attempts to explain it usually take a political economy-approach and rely on rather specific assumptions (see Limao and Panagariya [2002]). This section's results suggest that an anti-trade bias may be needed to make trade agreements self-enforcing and suggests that trade barriers be reassessed upon their value to reduce defection incentives.

2.4 Changes in Comparative Advantage

The previous section made the case for the use of subsidies to sustain self-enforcing trade agreements. This section will set the finding in a dynamic context in which productivities are changing over time.

As pointed out in connection with the SEC (2.13), a deeper pattern of comparative advantage (i.e. a larger parameter b) raises the value of cooperation more than the value of defection and makes free trade more likely. The present section takes a dynamic approach to this point and shows how a carving in of the comparative advantage can lead to gradual trade liberalization and explain the protection of declining industries. In a simple but suggestive way it will remove the assumption that the pattern of comparative advantage is constant over time. In a first step, the comparative advantage is assumed to deepen exogenously, i.e. independent of the trade policies the countries engage in. A single anticipated jump in export productivities leads to a gradual reduction of trade barriers, which sets in before the date of the technology change. Under the optimal dynamic agreement, the import-competing industries decline in the period of gradual trade liberalization. Consequently, the protection of declining industries can be part of an optimally designed trade agreement.
A second step connects the increase in the comparative advantage to a simple learning by doing process. When the deepening of comparative advantage takes place conditional on trade cooperation, agreements that eventually allow free trade may indeed *require* the transitional use of subsidies in favor of

import-competing industries.

2.4.1 An Exogenous Deepening of Comparative Advantages

In a repeated game where future gains form cooperation make players respect agreements at present, all upcoming events enter today's participation constraint. If for example some event increases gains from cooperation from tomorrow on, tomorrow's cooperation will be deeper and more beneficial. But this also increases today's value of respecting the agreement which, in turn, relaxes the present self-enforcement constraint and allows some degree of trade liberalization today already. The liberalization process is therefore gradual.

To explore this argument formally, assume that the productivity in the exporting sector, b, increases with a single exogenous jump at some future date t_0. Such a process $\{b_t\}$ is described by

$$b_t = \begin{cases} \underline{b} & if\ t < t_0 \\ \bar{b} & if\ t \geq t_0 \end{cases} \tag{2.17}$$

with $\bar{b} > \underline{b} > 1$. Rational agents anticipate this jump.
To save notation, drop the superscripts $(^A)$ and simply write (T, y) for the trade agreements. Further, for a given parameter b define the gain from defection relative to Nash outcome as $\delta(T, y; b) = u^D(T, y, b) - u^N(b)$ and the gain from cooperation relative to Nash outcome as $\xi(T, y; b) = u^C(T, y, b) - u^N(b)$. The participation constraint at time t can then be written as

$$\delta(T_t, y_t; b_t) \leq \sum_{\tau \geq t} \beta^\tau \xi(T_{t+\tau}, y_{t+\tau}; b_{t+\tau})$$

As an increase in b was shown to relax the static free trade self-enforcement constraint (2.13), it is possible to assume that free trade is sustainable under $\bar{b}$ but not under $\underline{b}$:

$$\delta(1, 0; \bar{b}) \leq \frac{1}{1-\beta}\xi(1, 0; \bar{b}) \qquad \delta(1, 0; \underline{b}) > \frac{1}{1-\beta}\xi(1, 0; \underline{b})$$

Then, assuming that t_0 is far enough in the future, free trade is not sustainable at $t = 0$. So there must be a time $t_1 \leq t_0$ such that free trade is sustainable ever after

$$\delta(1,0;b_{t_1}) \leq \frac{1-\beta^{t_0-t'}}{1-\beta}\xi(1,0;\underline{b}) + \frac{\beta^{t_0-t'}}{1-\beta}\xi(1,0;\bar{b}) \qquad t' \geq t_1$$

but at $t_1 - 1$ it is not:

$$\delta(1,0;b_{t_{1-1}}) > \frac{1-\beta^{t_0-t'+1}}{1-\beta}\xi(1,0;\underline{b}) + \frac{\beta^{t_0-t'+1}}{1-\beta}\xi(1,0;\bar{b})$$

Suppose again that countries always implement the efficient symmetric subgame perfect trade agreement. This means that from time t_1 onwards laisser-faire policies $(T,y) = (1,0)$ prevail. At time $t_1 - 1$, the optimal trade agreement maximizes cooperation utility $u^C(T_{t_1-1}, y_{t_1-1})$ subject to

$$\delta(T_{t_1-1}, y_{t_1-1}; \underline{b}) - \xi(T_{t_1-1}, y_{t_1-1}; \underline{b}) \leq \beta \sum_{\tau \geq 0} \beta^{\tau} \xi(1,0;b_{t_1+\tau}) \tag{2.18}$$

Note that by construction of t_1 the constraint must be binding such that the value function of this maximization problem is less than under laisser-faire, $u^C(1,0)$, and consequently the gains from cooperation will be less

$$\xi(T_{t_1-1}, y_{t_1-1}; \underline{b}) > \xi(T_{t_1}, y_{t_1}; \underline{b}) = \xi(1,0;\underline{b}) \tag{2.19}$$

The outcome of the maximization problem deliver the policy functions (T_{t_1-1}, y_{t_1-1}) for time $t_1 - 1$. At time $t_1 - 2$, governments take (T_{t_1-1}, y_{t_1-1}) as given to calculate the optimal sustainable trade agreement, maximizing $u^C(T_{t_1-2}, y_{t_1-2})$ s.t.

$$\begin{aligned} \delta(T_{t_1-2}, y_{t_1-2}; \underline{b}) - \xi(T_{t_1-2}, y_{t_1-2}; \underline{b}) \leq \beta\xi(T_{t_1-1}, y_{t_1-1}; \underline{b}) \\ +\beta \textstyle\sum_{\tau \geq 0} \beta^{\tau} \xi(1,0;b_{t_1+\tau}) \end{aligned} \tag{2.20}$$

Note that by (2.19) the RHS of (2.20) is larger than the RHS of (2.18) so the self-enforcement constraint at time $t_1 - 2$ (2.20) is tighter than at time $t_1 - 1$ (2.18). Consequently, the trade agreement at time $t_1 - 2$ (T_{t_1-2}, y_{t_1-2}) is less liberal than the one at $t_1 - 1$ (T_{t_1-1}, y_{t_1-1}). An induction argument completes the proof that, going backwards in time from t_1 onwards the trade agreement gets gradually less liberal.

It is quick to check that at each time, the optimality conditions for the trade agreements are identical with those of the problem (2.15). As both policy functions T^A and y^A of the maximization problem (2.15), are decreasing in the value function u^C (see appendix), tariffs and subsidies gradually grow smaller and eventually vanish. This finding is summarized in the following

Proposition 2 *An anticipated exogenous deepening of comparative advantage at time t_o increases the anticipated gains from the trade agreement. Thereby, it relaxes the self-enforcement constraint even before date t_o and consequently trade is liberalized gradually. During the liberalization period declining industries are protected.*

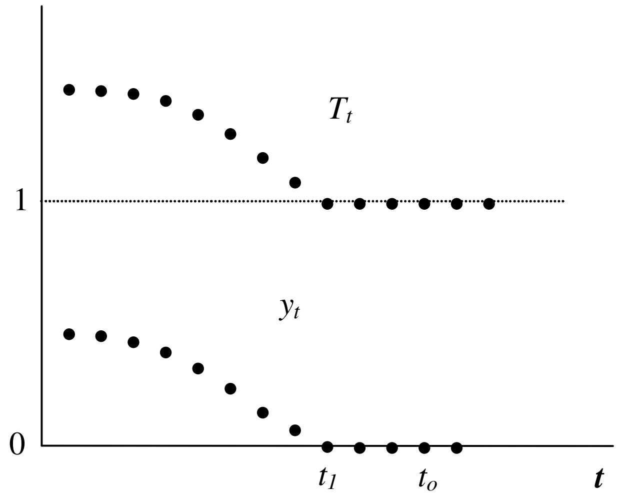

Figure 2.2: Optimal Trade Agreements and Gradualism

The proposition has two parts, which address gradualism of trade liberalization and the protection of declining sectors. While the finding of gradualism essentially repeats the result of Devereux [1997], the novel and interesting part of Proposition 2 is the fact that optimal trade agreements protect declining industries through tariffs and subsidies.

Figure 2.2 illustrates these dynamics. The jump of b allows for free trade after the date t_o. The anticipated increase in the gains from cooperation allow trade liberalization already *before* that date. The more distant t_o is, the heavier accruing gains are discounted and the higher is intervention through tariffs and subsidies.

Protection of declining industries is usually explained by political economy arguments. The contraction of an industry, a standard argument runs, is followed by a decrease in lobbying activity, which in turn leads to less protection and further decline (see Hillman [1982]). The explanation developed here, in contrast, relies on purely welfare-maximizing governments. Here, the reason for a stepwise reduction of protection does not come from the desire to cushion or reduce political resistance but it is an optimal policy because the self-enforcement constraint impedes to let them go at once. Some sectors simply have to be protected in order to guarantee self-enforceability of the agreement and as the self-enforcement constraint relaxes stepwise, they are gradually faded out.

The next part will explore the situation where the deepening of comparative advantage is conditional on trade cooperation.

2.4.2 Comparative Advantage and Learning by Doing

With a simple example, the following part highlights the prominent role subsidies can play in trade agreements. It shows that the transitional engagement in subsidies may be necessary in order to reach a free trade agreement. The mechanism draws on a learning by doing process combined with the Remark to Proposition 1 From Section 3. The learning by doing process can be such that a minimum degree of international specialization may be required for the comparative advantage to deepen. In addition, as the above remark states, subsidies might be indispensable to reach any kind of cooperation. Thus, cooperation, deepening of comparative advantage, and finally free trade may be reached through subsidies only. Consequently, if subsidies are banned altogether, the only sustainable outcome is an everlasting trade war.

Assume that there is sector-specific disembodied knowledge κ^z $(z = x, y)$, which accumulates through learning by doing. However, there has to be a minimum level of activity in each sector for the stock of knowledge to increase[8]. In particular, assume that evolves according to

$$\kappa^z_{t+1} = \kappa^z_t + \varepsilon_t \qquad \varepsilon_t = \begin{cases} \overline{\varepsilon} & if \quad z_t > \underline{b}/(\underline{b}+1) \\ 0 & else \end{cases} \tag{2.21}$$

[8]This assumption can be motivated in various ways. As one possible example, suppose that each period workers meet and talk. Talking creates insights and knowledge if and only if there is a critical mass of experts present - or a share of $\underline{b}/(\underline{b}+1)$. This leads to (2.21).

in Home and equivalently in Foreign. Finally, suppose that the stock of knowledge affects the aggregate productivity in the following simple way[9]:

$$b(\kappa^x) = \begin{cases} \overline{b} & if\ \kappa^x \geq \overline{\kappa} \\ \underline{b} & else \end{cases} \qquad \text{and} \qquad a(\kappa^y) = \begin{cases} \overline{a} & if\ \kappa^y \geq \overline{\kappa} \\ 1 & else \end{cases} \tag{2.22}$$

Under these conditions, there is will be no improvement in technologies under trade war since $\varepsilon_t = 0$. However, under international specialization the stock of knowledge in the exporting sector grows and pattern of comparative advantage deepens at some date t_0. The situation is now the same as in the previous subsection with the jump in export productivities according to (2.17) with the only difference that the jump in b is conditional on trade integration.

When initially $\underline{b}$ and β are such that $\beta < \beta^M(\underline{b})$ (compare (2.16)) and t_0 is far in the future, the effect of the additional gains on the self-enforcement constraint is negligible. Thus, the self-enforcement constraint is essentially the static one (2.13) and no efficiency-enhancing trade agreement is feasible without the use of subsidies. If in such a world subsidies are prohibited, no trade agreement will be put in place and consequently the technologies are not improving. All parameters remain constant over time and countries have no choice but living under a non-cooperative trade regime. However, when countries have the possibility to subsidize, a moderate liberalization will take place initially. This leads to some degree of specialization and by (2.21) the knowledge in the respective export-technologies starts to grow in every consecutive period, eventually leading to the jump in technologies. If the impact of the technology is large enough, it will lead to free trade ($\beta^{FT}(\overline{b}) < \beta$ - compare (2.14)). Repeating the logical steps that led to Proposition 2, one derives the following

Proposition 3 *Under learning by doing as in (2.21) and (2.22) and assuming that $\beta^{FT}(\overline{b}) < \beta < \beta^M(\underline{b})$, any self-enforcing trade agreement that eventually leads to free trade necessarily implements subsidies temporarily.*

This example illustrates that, somewhat paradoxically, certain sectors may decline and give way to liberalization only if they are temporarily protected. Countries that fear dependence on imports of essential goods may refuse to

[9] Assume e.g. that a certain amount of sector-specific knowledge is needed to adopt a new technology that makes b jump from $\underline{b}$ to $\overline{b}$.

enter trade agreements when they are not allowed to promote the domestic production of these goods by industry policies. However, if the agreement leaves this door open to them, they may partially open to trade, which sets them on the track that eventually leads to complete liberalization.

This sections made a strong case for the use of subsidies in trade agreements, pointing out some beneficial effects it can have in a competitive world. The results are in line with Bagwell and Staiger [2000] who argue that the banning of subsidies by the WTO "may ultimately do more harm than good to the multilateral trading system". It is useful, however, to highlight the qualifications of such reasoning. The next section will do so by highlighting the role of a flexible industrial structure.

2.5 Rigid Output Structure and Commitment

It was pointed out in sufficient detail that the previous sections' results require strong discounting and the imported goods to be essential. But there is another, less explicit assumption, which is crucial for the results. This assumption concerns the pace the two different policies can be adjusted with. In the previous sections, subsidies were modelled as flexible enough to be changed from period to period. In particular, the time to change tariffs and subsidies was assumed to be identical. Moreover, the policies' effects on the production structure were assumed to be immediate – adjustments in tariffs were supposed to take the same time as the birth and death of a country's entire industry. While for some highly flexible industries these assumptions can make sense, their general validity can surely be questioned.
An adjustment of national industrial structure can for instance be delayed because firms may time to build production capacities and thus cannot react immediately on policy changes. But policy changes that target industrial structure may by itself be slower than tariff adjustments: In its definition of subsidies, the WTO [1995] includes the public supply of sector-specific infrastructure which generally takes time to build. Moreover, as Rodrik [1995] points out, institutions tend to facilitate the use of revenue-generating policies (e.g. tariffs) compared to expenditure-generating ones (e.g. subsides) since the latter involve budget approval by different administrative bodies. In sum, when time-to-build and institutional or legal delays are not negligible, output structure of an economy is long-lived and slow to react on policy changes.

Reflecting these considerations, the present section treats the case where the horizon to change a country's patterns of production $((x, y),(x^*, y^*))$ is much more lengthy that the horizon of a tariff-change. It will become apparent that this change is not innocent and grossly qualifies the previous results.

2.5.1 Rigid Output Structure and Free Trade

Assume in the following that tariffs and subsidies can be changed in every period $t \in \mathbb{N}$. Suppose also, as in the previous sections, that whenever a government defects on a trade agreement, all other actors in the world economy, including firms, are taken by surprise and are unable to react on the spot. But unless the previous section, all firms are now assumed to need time to adjust production capacities such that output structure reacts with a time lag and does not change before L periods after a defection. Consequently, a defection at time $\underline{t}$ on a trade agreement (y^A, T^A) is followed by a trade war containing two different phases: up to period $\underline{t}+L$, cooperative output patterns (y^A, x^A) are unchanged but tariffs are set according to (2.8), rendering a punishment utility u^P. After that date strategies (2.10) prevail and utilities are as in (2.11). In a time-invariant setting, the trade agreement (y^A, T^A) is then self enforcing when condition (2.12) holds:

$$\frac{1}{1-\beta}u^C(y^A, T^A) \geq u^D(y^A, T^A) + \frac{\beta - \beta^{L+1}}{1-\beta}u^P(y^A, T^A) + \frac{\beta^{L+1}}{1-\beta}u^N$$

With the best response tariffs (2.8) one can now calculate that a defection on a free trade agreement $((y^A, T^A) = (0, 1))$, is followed by a punishment utility $u^P = 0$. Since $u^C = b/2$ and $u^D = b/\sqrt{2}$ as in section 3, the self enforcement constraint becomes

$$\beta \geq \frac{\sqrt{2} - 1}{\sqrt{2} - 2\beta^L u^N / b}$$

For $L = 0$ this condition coincides with (2.14). It becomes less and less strict with increasing L and is is least demanding for $L \to \infty$. This leads to the following

Proposition 4 *The less flexible the output structure, the more likely is the free trade to be self-enforceable.*

Proposition 4 illustrates the virtues of mutual dependence that arises when countries are heavily dependent on imports even after a breakdown of cooperation. By making defection less attractive, such mutual dependence serves as a commitment device and makes free trade sustainable when it would not be under more flexible output patterns. In fact, the deliberate destruction of capacities in import competing sectors may be an adequate policy by generating this dependency.
But can a sovereign country be expected to deliberately enter dependence to other nations? Although such a move seems not very likely at the first glance, this is a standard interpretation of what happened at the foundation of the European Coal and Steel Community (ECSC), the cooperation that laid the basis of the later European Union. The pooling of the essential goods steel and coal was meant to create a mutual dependence between the western European member nations that made future cooperation indispensable (see Gillingham [1991]). The strategic value of mutual dependence was pointed out in the Declaration of 9^{th} of May by emphasizing that "[t]he pooling of coal and steel production... will make it plain that any war between France and Germany becomes not merely unthinkable but materially impossible."

2.5.2 Subsidies and Rigid Output Structure

The remainder of this section analyzes how subsidizing import-competing sectors impacts the self-enforcement constraint. It will be shown that Proposition 1 does not generalize under the persistent industrial structure assumed here. To analyze this scenario, use (2.4) and (2.9) to calculate the punishment utility u^P under a symmetric output structure:

$$u^P = (b(1-y)+y)\,\frac{\sqrt[4]{b(1/y-1)}}{\sqrt{b(1/y-1)}+1} \tag{2.23}$$

As can be read from (2.23), small amounts of domestic production of the essential imported good make a trade war less threatening. Obviously, with the adequate production capacities at hand a trade war does not seem so bad. But a increase in punishment utility increases the value of defection and thereby tends to *tighten* the self-enforcement constraint, making cooperation less likely.
This remarkably opposes the finding from Proposition 1. Of course, the effect isolated here is not the only one and the force described in the previous

sections that *relaxes* the self enforcement constraint with import-competing production is still present. However, it can be shown that the negative effect prevails at the margin such that small amounts of import competing production unambiguously tighten the self-enforcement constraint. The consequence is the following

Proposition 5 *Under rigid output patterns, small amounts of subsidies for import competing sectors unambiguously tighten the self-enforcement constraint and the optimal trade agreement either employs subsidies in large amounts or not at all.*

Proof. See Appendix. ■

Figure 2.3 illustrates the finding of the proposition. In the top panel, there are now three different ranges for the discount factor. At high levels, the economy is undistorted under the optimal agreement. For intermediate values, free trade is not sustainable but only a moderate relaxation of the self-enforcement constraint (2.12) is required. For those small relaxations a promotion of the import-competing sectors is inadequate since it optimally is either null or big time. For even lower β positive tariffs are not enough to make a trade agreement self-enforceable and both, tariffs and subsidies, are employed in positive quantities.

It is worth stressing that the disciplinary forces in Propositions 1 and 5 are very distinct. When tariffs and output patterns are equally quick to change, stimulating small quantities of domestic production of the imported good reduce the *foreign* country's incentives to defect on the agreement. In the case of rigid output patterns, the commitment device aims to tie ones hands and is directed against the own defection incentives. The two effects highlight the fact that to sustain trade agreements, at least one of the two is needed: one-time defection has to appear little attractive or future consequences of defection must be severe.

This last section has drawn the attention to one limitation of this chapter's main argument. It has illustrated how mutual dependence fosters cooperation by making defection very costly for all sides. At the same time, it has offered an alternative view on the WTO's strict ruling on subsidies and qualified Bagwell and Staiger's [2004] assessment that "WTO subsidy rules may ultimately do more harm than good to the multilateral trading system". One might hope, in the spirit of this section, for a sufficient degree of symmetry among countries (and among goods), such that impeding subsidies fosters

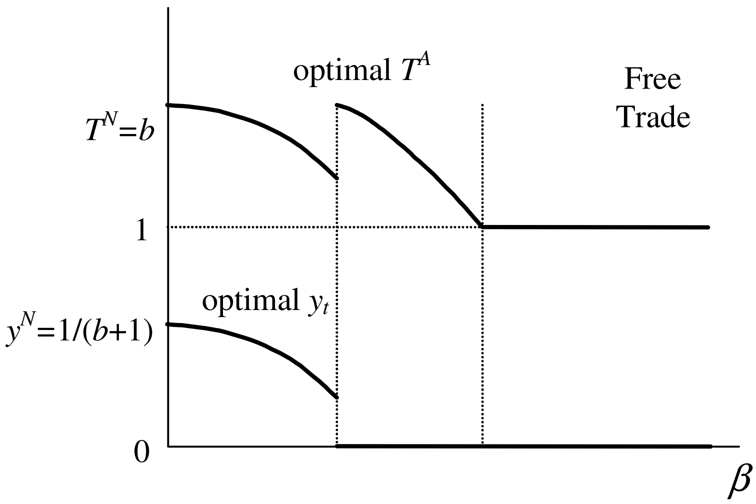

Figure 2.3: Optimal Trade Agreements Under Rigid Output Structure

mutual dependence and eventually makes it impossible for countries to opt out of the world trading community, driving trade cooperation ahead. A more pessimistic conclusion of the current section predicts cartel formation on the world market coming along with a further international specialization due to the ban of production subsidies - or alternatively, if such a scenario is rationally foreseen, the halt or setback of trade liberalization because of fears of such a scenario.

2.6 Conclusion

This chapter has argued that in a world where governments are maximizing social welfare and in absence of interest groups, the use of subsidies can be part of a optimal strategy that makes international trade agreements self-enforcing. Optimal interventions must favor comparatively disadvantaged, import-competing sectors. The distortions the interventionist policies create are the price that must be paid to prevent severer damage from a trade war. Preconditions for these results are low elasticities of demand of the import-goods, strong discounting of future benefits, and flexibility in the industrial structure of countries. A dynamic extension of the model has introduced a

simple learning by doing process and provided a rationale for the protection of declining industries.
A final extension of the model has drawn the attention to the role of the flexibility of the industrial structure. When output patterns are slow to change, mutual dependence can serve as a commitment device, encouraging adherence to an agreement. In this case the stimulation of import competing sectors may even undermine trade agreements, and deliberate creation of mutual dependence through a policy that works against import-competing sectors fosters free trade.

Appendix Chapter 2

I. The Nash Equilibrium. Prove that (2.10) describe a Nash Equilibrium of the problem (2.7).
Note that by fixing minimum output in both sectors, Home can choose its output pattern (y, x) directly. Consequently, the program (2.7) is equivalent to maximizing (2.4) over T and y subject to (2.5) and the resource constraint:

$$\max_{T,y} \left(\frac{x + yp}{\sqrt{p}} \frac{\sqrt{T}}{T+1} \right) \qquad s.t. \;\; (2.5) \;\; \text{and} \quad x = b(1-y) \tag{A1}$$

Dealing with the two-dimensional maximization problem requires in general the calculation and evaluation of the Hessian. This is a route that one should try to avoid. Fortunately, a unique and closed form solution the best response function of the tariff has been derived by Kennan and Riezman [1988] and can be replicated by establishing the FOC w.r.t. tariff T

$$\left(\frac{py}{x+py} - \frac{1}{2} \right) \frac{d}{dT} \ln(p) + \frac{1}{2T} - \frac{1}{T+1} = 0$$

Using (2.5) gives

$$\frac{d}{dT} \ln(p) = \frac{x^* T^*}{x^* T^* (T+1) + x(T^*+1)} - \frac{y(T^*+1) + y^*}{yT(T^*+1) + y^*(T+1)} \tag{A2}$$

and leads to

$$T(T^*, x^*) = \sqrt{\frac{y^*}{x^*} \cdot \frac{x^* + x(1 + 1/T^*)}{y^* + y(T^*+1)}} \tag{A3}$$

Whatever the best strategy of output may be, (A3) establishes the unique best response tariff. To derive the optimal output (y, x), use $x = b(1-y)$ and set $du/dy = 0$:

$$\frac{p}{x+py} + \frac{1}{2} \left(\frac{py - x}{x + py} \right) \frac{d}{dy} \ln(p) = 0 \tag{A4}$$

The derivative of the price (2.5)

$$\frac{d}{dy} \ln(p) = \frac{-b(T^*+1)}{x^* T^* (T+1) + x(T^*+1)} - \frac{T(T^*+1)}{yT(T^*+1) + y^*(T+1)} \tag{A5}$$

which gives

$$
\begin{aligned}
0 &= 2\frac{x(T^*+1)+x^*-b(y(T^*+1)+y^*)}{xy(T^*+1)+xy^*+yx^*} \\
&\quad -\frac{T^*+1}{y(T^*+1)+y^*(1+1/T)}+b\frac{T^*+1}{x(T^*+1)+x^*T^*(T+1)}
\end{aligned}
$$

This is a necessary condition an (interior) Nash equilibrium has to satisfy. For a potential symmetric equilibrium ($T=T^*$, $y=x^*$), it implied

$$
y=\frac{\max\{T+2-b;0\}}{3b(T+1)-b^2-T} \tag{A6}
$$

(Note that for the relevant range ($b>1$ and $T\geq 1$) the denominator is positive as long as the numerator is so.) Finally, (A3) and (A6) together give

$$
T^N=b \qquad y^N=\frac{1}{b+1} \qquad x^N=\frac{b^2}{b+1} \tag{A7}
$$

To complete the proof that (A7) in fact determines a Nash Equilibrium, set Foreign variables according to (A7), i.e. $T^*=b$ and $x^*=\frac{1}{b+1}$. Writing further the short-hand $p=r_1/r_2$ with $r_1=b(T+1)+x(b+1)^2$ and $r_2=b^2(T+1)+yT(b+1)^2$, equations (A4) and (A5) give

$$
2\left(br_2-r_1\right)=(b+1)^2(br_2+Tr_1)\left(\frac{x}{r_2}-\frac{y}{r_1}\right)
$$

The LHS of that equation is increasing in y while the RHS is decreasing in y ((br_2+Tr_1) and $x/r_2-y/r_1$ are positive and decreasing in y). As the choice variables are restricted to a compact set $(y,T)\in[0,1]\times[1,2b]$ (see (A3)), this proves that the unique optimal response on $T^*=b$ and $x^*=\frac{1}{b+1}$ for Home is given by (A7). ■

II. Proof of Proposition 1. First step: $y^A>0$ and $T^A>1$ when the SEC binds.
Setting $y=x^*=y^A$ and using equations (2.4), (2.5), and (A3), one gets

$$
\left.\frac{d}{dy^A}\ln(u^D)\right|_{y^A=0}=-\frac{c_o}{\sqrt{y^A}}+o\left(1/\sqrt{y^A}\right) \tag{A8}
$$

where c_o is positive and a constant in y^A. Taking derivatives of the RHS of (2.13) delivers

$$\frac{d}{dy^A}RHS = \frac{d}{dy^A}\left(1 - \frac{u^C - u^N}{u^D - u^N}\right) = -\frac{1}{u^D - u^N}\frac{du^C}{dy^A} + \frac{u^C - u^N}{(u^D - u^N)^2}\frac{du^D}{dy^A}$$

Since du^C/dy^A is finite, this derivative must be negative and unbounded at $y^A = 0$. Thus, small amounts of import-competing production relax the SEC at a cost-benefit ratio of zero. Consequently, the problem (2.15) has an interior solution, i.e. $y^A > 0$, as soon as the SEC binds. As further $du^C/dT^A = 0$, one has

$$\left.\frac{d}{dT^A}RHS\right|_{T^A=1} = \left.\frac{u^C - u^N}{(u^D - u^N)^2}\frac{du^D}{dT^A}\right|_{T^A=1} < 0$$

one gets that small tariffs relax the SEC at a cost-benefit ratio of zero and, by the same logic as above, $T^A > 1$ when the SEC binds.

Second step:.y^A and T^A are non-decreasing in β.
First define the differences between cooperation and trade war utility, and between defection and trade war utility as

$$\begin{aligned} \Delta^C(y^A, T^A) &= u^C(y^A, T^A) - u^N \\ \Delta^D(y^A, T^A) &= u^D(y^A, T^A) - u^N \end{aligned}$$

When the constraint binds (i.e. when $(1-\beta)\Delta^D - \Delta^C = 0$), the solution ($y^A$,$T^A$) is interior and can take derivatives implicitly to get

$$\frac{dy^A}{d\beta} = \frac{\Delta^D/\Delta^C}{\Delta^C_y/\Delta^C - \Delta^D_y/\Delta^D} \tag{A9}$$

Now, (2.4) gives $d\Delta^C/dy^A < 0$. Using this, $d(\Delta^C/\Delta^D)/dy^A \leq 0$ contradicts optimality of the trade agreement such that $d(\Delta^C/\Delta^D)/dy^A > 0$ must hold. Together with $\Delta^C, \Delta^D > 0$ this proves that (A9) is negative. The equivalent reasoning for optimal tariffs T^A leads to $dT^A/d\beta < 0$.

Third step. Subsidies go to the import competing, not to the export competing sector.

At $\beta = 0$ the optimal sustainable tariff is $T^N = b$. Since $dT^A/d\beta < 0$, this means that $T^A < b$ for $\beta > 0$. As $p = 1$ in the symmetric equilibrium, one gets $pT^A < b$. With (2.6) this proves the statement and completes the proof of Proposition 1. ■

III. Proof of Proposition 5. Verify that

$$\frac{d}{dy^A} u^P(T^A, y^A) = \frac{c_1}{(y^A)^{3/4}} + o\left((y^A)^{-3/4}\right) \tag{A10}$$

with $c_1 > 0$. Since du^P/dy^A increase at a higher order than du^D/dy^A decreases, one gets

$$\frac{d}{dy^A}\left(\frac{u^D - u^C}{u^D - u^P}\right)\Bigg|_{y^A=0} = +\infty$$

In other words, small amounts of import-competing production tighten the SEC. Further, they induce efficiency losses. This proves the proposition. ■

References

Bagwell, K., Staiger, R. W., [2000]. GATT-Think. NBER Working Paper W8005

Bagwell, K., Staiger, R. W., [2001]. Domestic Policies, National Sovereignty, and International Economic Institutions Quarterly Journal of Economics 116, pp. 519–562.

Bagwell, K., Staiger, R. W., [2004] Subsidy Agreements. NBER Working Paper W10292

Bradford, S., [2003]. Protection and jobs: explaining the structure of trade barriers across industries. Journal of International Economics 61, 19–39.

Devereux, M. B., [1997]. Growth, Specialization and Trade Liberalization. International Economic Review 38, 565–585.

Dixit, A., [1987]. Strategic Aspects of Trade Policy, in: Truman, F. (Ed.), Advances in Economic Theory, Fifth World Congress, Cambridge University Press, New York, pp. 329-362.

Fernandez, R., Rodrik, D., [1991]. Why is Trade Reform so Unpopular? On Status Quo Bias in Policy Reforms. American Economic Review 81, 1146–1155.

Furusawa, T., Lai, E., [1999]. Adjustment Costs and Gradual Trade Liberalization. Journal of International Economics 49, 333-361.

Gillingham, J., [1991]. Coal, Steel, and the Rebirth of Europe 1945-1955. The Germans and French from the Ruhr Conflict to the Economic Community" Cambridge

Grossman, G. M., Helpman, E., [1994]. Protection for Sale. American Economic Review 84, 833–850.

Goldberg, P. K., Maggi, G., [1999]. Protection for Sale: an Empirical Investigation. American Economic Review 89, 1135–1155.

Hillman, A. L., [1982]. Declining Industries and political-support protectionist motives American Economic Review 72, 1180–1187.

Kennan, J., Riezman, R., [1988]. Do Big Countries Win Tariff Wars?. International Economic Review 29, 81-85.

Kohl, W. L., [1991]. After the Oil Price Collapse. John Hopkins University Press, London

Lee, J.-W., Swagel, P., [1997]. Trade Barriers and Trade Flows Across Countries and Industries. Review of Economics and Statistics 79, 372-382.

Limao, N., Panagariya, A., [2002]. Why is there an Anti-Trade Bias in Trade Policy? UMD Center for International Economics WP 02-03

McLaren, J., [1997]. Size, Sunk Costs, and Judge Bowker's Objection to Free Trade American Economic Review 87, 400-420.

Rodrik, D., [1995]. Political Economy of Trade Policy, in: Grossman, G. M., Rogoff, K., (Eds.), Handbook of International Economics, Vol. 3 Amsterdam, North-Holland, pp. 1457-1494.

Staiger, R. W., [1995]. A Theory of Gradual Trade Liberalization, in: Levinsohn, J., Deardorff, A. V., Stern, R. M. (Eds.), New Directions in Trade Theory. University of Michigan Press, pp. 249–284.

Trefler, D., [1993]. Trade Liberalization and the Theory of Endogenous Protection: An Economic Study of US Import Policy. Journal of Political Economy 101, 138-160.

WTO, [1995], Agreement Establishing the WTO, Annex 1, Agreement on Subsidies and Countervailing Measures