

ESSAYS ON TRADE POLICY AND EDUCATION CHOICE

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Preface

This thesis is about two major economic topics, trade policy and education choice. The first and the second essay analyze trade policy with special attention to tariff formation in intermediate-good sectors. The first essay explains tariff formation in intermediate-good sectors from a national perspective. I build a political economy model in which lobby groups try to influence the government, which is both concerned about social welfare and collecting contributions from the lobby groups. It turns out that in such a model the equilibrium tariffs on intermediate goods deviate systematically from the tariffs on final goods. The second essay analyzes the tariff formation in intermediate-good sectors from an international perspective. It shows in a strategic trade policy model that the consideration of intermediate goods has a strong effect on the government's optimal policy towards final goods also. The third essay is about education choice. I introduce social preferences into a simple model of education choice. Social preferences mean that individuals are not only concerned about their material self-interest, but also about their relative income in comparison to others. It is shown that the individuals with social preferences take a systematically different education choice than purely self-interested individuals. The results can explain empirical evidence concerning the educational success of students.

In the remainder of this preface, I will introduce the two topics in more detail and explain what my research contributes to the existing literature.

Trade policy

The most prominent theories to explain the existence of tariffs and subsidies are the theory of the political economy of trade policy and the theory of strategic trade policy. The former assumes that governments are not only concerned about the national welfare, but also follow own interests. These interests can be reelection motives or the collection of contributions. In the seminal paper in this field, written by

Grossman and Helpman (1994), lobby groups try to influence the government's trade policy in their favor by offering contributions conditioned on trade policy. The theory of strategic trade policy explains policy interventions (often subsidies) by imperfect competition as trade policy can then improve the strategic position of domestic in comparison to foreign firms. A strategic relationship between domestic and foreign firms is given if they compete in their own or third markets and thereby influence each others' profits. Seminal papers in this field are Brander and Spencer (1985) and Eaton and Grossman (1986). In both the political economy of trade policy and the strategic trade policy there exists an extensive literature on their functioning for final goods. The model of Grossman and Helpman (1994) has been extended to a two-country framework (Grossman and Helpman 1995), to endogenous lobby formation (Mitra 1999), to other policy instruments than tariffs like quotas and VERs (Maggi and Rodriguez-Clare 2000), by the consideration of labor interests (Rama and Tabellini 1998 and Matschke 2004), and to monopolistic competition (Chang 2005). Among other things, the literature on strategic trade policy covers the following areas: The role R&D can play in strategic trade policy (Spencer and Brander 1983 and Bagwell and Staiger 1994), the importance of timing for the outcome of strategic trade policy (Carmichael 1987 and Gruenspecht 1988), how a repeated-game structure changes strategic trade policy (Davidson 1984 and Rotemberg and Saloner 1989), the impact of asymmetric information between the firms and the government (Qiu 1994), and how entry and exit of firms influences strategic trade policy (Dixit and Kyle 1985, Venables 1985, and Bagwell and Staiger 1992). While all these approaches analyze final goods, there is a growing literature in both fields that seeks to answer whether the results found for final goods also apply to intermediate goods. In the following, I describe more precisely how my first two essays contribute to the literature on intermediate goods.

Tariff Formation in Upstream Industries with Labor Interests. As already mentioned, the literature on the political economy of trade policy has mainly focused on explaining tariffs on final goods. There are two recent approaches by Gawande and Krishna (2005) and by Lopez and Matschke (2006) that consider intermediate goods, but they do so in a different way and with a different focus than I do. In my essay, I extend the seminal model of tariff formation in final goods, by Grossman and Helpman (1994), by adding intermediate goods and labor interests. Thereby, I can give an explanation for the empirical observation (see, e.g., Baack and Ray 1983, Marvel and Ray 1983, and Ray 1991) of higher tariffs on final goods compared to

intermediate goods. The reason that tariffs on intermediate goods deviate from tariffs on final goods is that different conflicts of interests exist for both kinds of goods in my model. In the case of final goods, owners of factors of production seek positive tariffs on their goods as they increase their profits, while consumers suffer from tariffs as consumption gets more expensive. If factor owners are organized in lobbies, in equilibrium there will almost always be (as long as not all individuals are organized in lobby groups) a positive tariff on their good. In the case of intermediate goods, the owners of the factors of intermediate-good production lobby in favor of a tariff. But, factor owners in final-good sectors that need the intermediate good for their production lobby against tariffs as they increase their input prices. Therefore, it depends on industry characteristics whether there is a positive tariff on an intermediate good in case of sectoral lobbying. Labor interests are created in my model by the introduction of unions and endogenous unemployment benefits. Research by Rama and Tabellini (1998) shows that labor market distortions increase tariffs in final-good sectors. My essay demonstrates that this result does not hold for intermediate-good sectors. Hence, it is not feasible in general to resolve labor market distortions by reducing tariffs as Rama and Tabellini suggest.

The Risk of Vertical Specialization for Strategic Trade Policy. The literature on intermediate goods in the field of strategic trade policy is already further developed than the literature in the field of the political economy of trade policy. I only want to discuss two approaches here, which are most closely related to my own work. Bernhofen (1997) introduces a vertical structure into the model of Brander and Spencer (1985). In his approach, a foreign monopolist supplies inputs that both final-good producing firms need for their production. Thereby, the incentive to subsidize final-good production is reduced as a subsidy not only shifts profits horizontally, but also vertically. If the intermediate-good supplier can price discriminate between the final-good producers, the optimal policy even changes to a tax on final-good production. Ishikawa and Spencer (1999) analyze the role of intermediate goods in a model where an intermediate and a final good are produced in two countries. With the assumption of Cournot competition, an export subsidy aimed at shifting rents from foreign to domestic final-good producers may also shift rents to foreign intermediate-good suppliers. Thus, as long as a subsidy increases the price of the intermediate good, the desirability of a subsidy is smaller the more intermediate-good producers are foreign. These two approaches (and the literature on intermediate goods and strategic trade policy in general) have in common that the industry distribution over countries is symmetric.

But, there is a trend in industrialized countries to concentrate on the production of final goods and to outsource the production of intermediate goods. Hence, my second essay is about a case where industry distribution over countries is asymmetric: In a successive international Cournot duopoly, I analyze the different strategic options countries with and without domestic intermediate-good production have. Domestic intermediate-good production may give a country a strategic advantage as it can subsidize its final-good production more aggressively. I build a framework in which three countries are engaged in trade policy. One with intermediate- and final-good production, one only with intermediate-good production and one only with final-good production. I show that the country with both industries typically dominates the other countries' policy. It subsidizes its production more aggressively both in the intermediate- and in the final-good sector. Additionally, there are interesting interactions between the non-specialized country's policy towards its intermediate- and final-good production. One surprising result is for example that the subsidization of final-good production can be decreasing with the relative efficiency of domestic production. This can be the case if the non-specialized country's intermediate-good producer captures a large share of the profits shifted vertically.

Education Choice

A student's academic success can be explained in a variety of ways. Often it is seen as a result of the exogenous influences a student is exposed to in and outside school. As the main influences on educational outcome at school, broad branches of the literature on education discuss class-size effects (see, e.g., Angrist and Lavy 1999, Case and Deaton 1999, Krueger 1999, and Wößmann and West 2006), the teacher quality (see, e.g., Hanushek 1986, Hedges, Laine, and Greenwald 1994, and Angrist and Lavy 2001) and the effects of grouping students by ability (see, e.g., Figlio and Page 2002, Meghir and Palme 2005, and Hanushek and Wößmann 2006). The latter are often explained by peer group effects, how the influence is labeled that classmates have on a student's educational achievement. These are empirically well established (see, e.g., Hoxby 2000, Sacerdote 2001, and Robertson and Symons 2003) and explained as spillover effects or as a result of bad students' tendency to disrupt class (Lazear 2001). Outside school, the family background is empirically established as the main influence on a student's academic success (see, e.g., Solon 1992, Mulligan 1997, and Fuchs and Wößmann 2006). There are many explanations why a good family background can improve a child's education opportunities (see Piketty 2000 for

an excellent overview). Often used are the family transmission of ability, imperfect capital markets, local segregation or self-fulfilling beliefs. All those theories have in common that they neglect the importance of a student's own motivation for his or her educational achievement. What do the best exogenous educational opportunities help, if a student does not learn at home, does not concentrate at school, i.e. does not spend effort in education? It is certainly true that a student who is only interested in his material self-interest will spend more effort in education the better the exogenous opportunities are as they increase his return to education. But, recent research on individuals' preferences indicates that individuals are not only interested in their material self-interest, but also in their relative income in comparison to others. In my third essay, I integrate those so called 'social preferences' in a simple model of educational choice and analyze how they change individuals' education choices.

Education Choice with Social Preferences. The importance of family background and social environment for individuals' academic attainment is, as mentioned above, empirically well established. Surprisingly, there is only little theoretical research linking individuals' education choice with these external influences (see Akerlof and Kranton 2002 and Bishop 2006 for alternative approaches). Therefore, I build a simple education choice model where individuals do not only care about their material self-interest, but also about their relative income in comparison to others. Recent experimental studies (Fehr and Schmidt 1999, Fehr and Gaechter 2000, and Henrich et al. 2001) underline the importance of such social preferences in individuals' economic decisions. I show that with social preferences individuals' time investment in education is no longer increasing with ability and individuals with relatively rich parents invest systematically more time in education than individuals with relatively poor parents. By the latter result, my model offers a new explanation for the persistence of inter-generational income inequality. Additionally it is shown, that with the assumption of a high correlation between parental and peers' income, effort spend in education increases with the peers' income.

Chapter 1

Tariff Formation in Upstream Industries with Labor Interests

1.1 Introduction

The explanation of tariff variation across industries has evoked a lot of research activity at least since the early nineties. The seminal approach of Grossman and Helpman (1994) explains different tariffs across industries by introducing lobbying into the analysis. Following Grossman and Helpman, a branch of political economy literature extended¹ and tested² their model in a variety of settings. Interestingly, all these papers focus on the tariff formation in final-good sectors rather than intermediate-good sectors. But trade with intermediate goods covers around half of developed countries' trade and several empirical studies (see, e.g., Baack and Ray 1983, Marvel and Ray 1983, and Ray 1991) show systematic differences between the protection of final-good and intermediate-good sectors. Thus, the aim of this chapter is to analyze the tariff formation in intermediate-good sectors.³ The main questions that arise are: Where do the differences in protection between final and intermediate-good sectors come from? Do the determinants in tariff formation effect tariffs on intermediate goods in the same way as tariffs on final goods? Which new effects have to be considered for tariff forma-

¹See, e.g., Grossman and Helpman (1995), Rama and Tabellini (1998), Mitra (1999), Maggi and Rodriguez-Clare (2000), Matschke (2004), and Chang (2005).

²See, e.g., Goldberg and Maggi (1999), Gawande and Bandyopadhyay (2000), Eicher and Osang (2002), Mitra et al. (2002, 2006), McCalman (2004), Esfahani (2005), and Matschke and Sherlund (2006).

³Two recent papers, by Gawande and Krishna (2005) and by Lopez and Matschke (2006), also integrate intermediate goods in the framework of Grossman and Helpman. But, they do so in a different way and with a different focus of interest.

tion in intermediate-good sectors? To answer these questions, my approach does not restrict interest to final goods, but additionally integrates intermediate goods in the framework of Grossman and Helpman (1994). It is shown that differences in protection are mainly driven by the different conflicts of interests that occur in intermediate-good sectors in comparison to final-good sectors. Protection of intermediate-good sectors hurts final-good producers and thus induces them to engage against it. Hence, there is a conflict between two groups of producers, while in final-good sectors producers' interests are in conflict with consumers' interests alone. Lobbying against a large group of consumers, that is only slightly affected by a tariff, leads to other results than lobbying against a small group of producers, that is affected substantially by a tariff.

A second direction in which my model extends Grossman and Helpman deals with labor market distortions. While the role of specific capital interests in tariff formation has often been emphasized, there is only little research which integrates labor market interests (see Rama and Tabellini 1998 and Matschke 2004). This is surprising as empirics show that labor issues matter in tariff formation (see, e.g., Andersen 1980, Marvel and Ray 1983, and Ray 1991). In the original Grossman and Helpman framework, labor is assumed to be mobile across sectors. Thereby, only sector-specific capital benefits from protection and organizes itself in lobby groups to increase its sectoral tariff. However, besides capital owners, employees also benefit from trade protection. Both sectoral employment and wages increase if tariffs rise.⁴ Thus, labor unions have an incentive to influence trade policies, too. While capital owners and labor unions agree upon the desired direction of trade policy, they disagree concerning labor market policies. Employees want to be protected by the government via unemployment benefits, while capital owners oppose them. An empirical paper by Matschke and Sherlund (2006) confirms the explanatory power of labor market interests within a modified Grossman and Helpman framework. The reason to integrate labor market distortions into my model are the different effects they have on tariffs on intermediate goods in comparison to final goods.

Rama and Tabellini (1998) were the first to deal with labor interests in a Grossman and Helpman setting. In their model capital owners and union members lobby the government on both tariffs and minimum wages. Their main result is that trade barriers and labor market distortions move in the same direction. They draw the conclusion that foreign organizations can resolve a country's labor market distortions by reducing its tariffs rather than target labor markets directly. With my approach, I show that

⁴At least with the small country assumption.

such a policy can fail, since it may not work for intermediate-good sectors.

To integrate labor market rigidities into my model, I use a simplified version of the framework developed by Matschke (2004). Her approach is more general in comparison to Rama and Tabellini and is closer to the original Grossman and Helpman setting. Matschke's results confirm the findings of Rama and Tabellini. In her model (exogenous) unemployment benefits increase tariffs. But, it is critical for the results of both, Rama and Tabellini (1998) and Matschke (2004), that they examine final-good sectors. As already mentioned, I can show that their results do not carry through to the case of intermediate goods. Unemployment benefits and tariffs are positively correlated if tariffs decrease sectoral unemployment and thereby social costs of unemployment. This is always the case in final-good sectors, in which tariffs increase production and employment at the cost of consumers. But in intermediate-good sectors, it is ambiguous whether an increase in tariffs reduces sectoral unemployment or not. On the one hand, higher tariffs increase employment in the intermediate-good sector, but on the other hand, they decrease employment in dependent final-good sectors. Thus, it depends upon industry characteristics whether it is possible to resolve labor market distortions via trade policy as Rama and Tabellini suggest.

Across intermediate-good sectors, the main source of tariff variation is the relative size of dependent final-good sectors in comparison to intermediate-good sectors. This relative size influences the tariff in two ways. On the one hand, the size of a sector determines the strength of its lobbying. Thus, large final-good industries can prevent tariffs on their inputs. The same argument holds for the need of inputs in final-good production. The higher this need, the stronger is the opposition of final-good producers against tariffs on their inputs and thereby the smaller are the tariffs. On the other hand, the larger a final-good sector and the higher its dependence on an intermediate good, the more devastating is the impact of an intermediate-good tariff on the economy-wide unemployment. Thereby, the social costs of tariffs in those sectors are higher. Therefore, the government which cares not only about collecting contributions, but also about social welfare sets smaller tariffs. A third determinant of tariffs in intermediate-good sectors are tariff revenues. The lobbies in all sectors in which production is independent of a certain intermediate good prefer import tariffs on that good, if it is an import good, and export tariffs otherwise.

An additional insight the model provides is the interaction of tariffs in connected intermediate- and final-good sectors. Gawande and Bandyopadhyay (2000) already examined both theoretically and empirically how exogenous tariffs on intermediate

goods influence tariffs on final goods. Empirics support their theoretical prediction that tariffs on final goods are positively correlated with tariffs on intermediate goods used in the final-good production. My model supports this result and shows additionally that the same is true in the other direction. Tariffs on a final good increase the tariffs on the connected intermediate goods.

In summary, my model is the first that provides a theoretical explanation for the variance of tariffs on intermediate goods in a political economy framework. The model detects the sources of different tariff levels in final- and intermediate-good sectors. Consideration of labor interest gives new insights into the interactions between trade and labor market policies. The results concerning tariffs on intermediate goods contradict results that have been derived for final goods and give more differentiated policy advices for trade and labor market policies.

The rest of the chapter is organized as follows. Section 1.2 describes the model framework. The equilibrium policy is described and interpreted in Section 1.3. Section 1.4 concludes. The Appendix contains some derivations that are needed for the calculation of the equilibrium policy.

1.2 The Model

The model describes an economy that consists of $n + 1$ sectors. Every non-numeraire sector⁵ is divided into one intermediate and one final-good subsector. Within each sector, intermediate goods are needed for production of final goods. This means that a final-good producer can not substitute the intermediate good produced in his sector by an intermediate good from another sector (but may import the intermediate good from abroad). On the other hand, intermediate-good producers can only serve the final-good producers in their sector or export their good. As in Grossman and Helpman (1994), there is an exogenous world market price p_i^* of final goods in sector i . Assuming a small country, national prices are determined by $p_i = p_i^* + t_i^F$, where t_i^F is the tariff on the final good in sector i chosen by the government. For the intermediate goods, there is a separated world market price q_i^* and a separated national price $q_i = q_i^* + t_i^I$. The tariff on the intermediate good in sector i t_i^I is chosen by the government separately from the tariffs on final goods. For an importing subsector $t_i^j > 0$ ($t_i^j < 0$) is equivalent to an import tariff (import subsidy). In an exporting subsector $t_i^j > 0$ ($t_i^j < 0$)

⁵The $n+1$ th sector is a numeraire sector, which simplifies the modeling of consumption. If not explicitly mentioned, we will only talk about nonnumeraire sectors in what follows.

describes an export subsidy (export tax). It is assumed that one unit of the final good is produced with a fixed share β_i of the intermediate good. Thus, final-good producers suffer from tariffs on intermediate goods in their sector. All subsectors are provided with sector-specific capital K_i^j and labor L_i^j , where the index $j = F, I$ stands for final-good or intermediate-good subsectors. Production $F^{ij}(K_i^j, \alpha_i^j L_i^j)$ uses sectoral capital and labor and its functions F^{ij} are weakly concave with positive cross-derivatives. α_i^j denotes the share of employment per subsector. The described setting gives both capital owners and workers an incentive to organize in lobbies to influence trade policy. As producers, both capital lobbies and trade unions lobby for protection of their own sector, while as consumers, they lobby against protection of final goods in other sectors. Final-good producers lobby additionally against tariffs on intermediate goods in their sector, as these tariffs increase their input prices. Besides trade policy, the government can use unemployment benefits u as an additional policy instrument. With its labor market policy, the government is able to redistribute from capital to labor. Therefore, trade unions lobby for high unemployment benefits, while capital lobbies oppose them. The government could be induced to use this socially harmful instrument, if trade unions have a higher influence on policy than capital lobbies. All in all, the government controls three redistributive policy instruments. With tariffs on final goods, the government can protect final-good producers at the expense of consumers. Tariffs on intermediate goods support intermediate-good producers and hurt final-good producers. Finally, the national-wide even unemployment benefits help all workers and harm all capital owners.

The model has to formalize two interlinked decision problems. On the one hand, capital owners and trade unions have to agree upon wages and employment in all subsectors; on the other hand, the government needs to decide upon its policy, while all lobbies try to influence the government's decision. Following Matschke (2004), it seems to be reasonable to assume that bargaining about employment and wages takes place more often than reconsiderations of trade and labor market policy. That is, capital lobbies and unions take tariffs and unemployment benefits as given for their employment bargaining. This assumption gives the model a two-stage structure. In the first stage, tariffs and unemployment benefits are realized in a menu auction between all lobbies and the government. In the second stage, wages and employment are determined by Nash bargaining between capitalists and workers with given tariffs and unemployment benefits. This game has to be solved by backward induction. The next section will describe the outcome of the wage bargaining in stage two, while afterwards the policy game in stage one will be solved.

1.2.1 Wage Bargaining

In every subsector, the wage w_i^j and the share of employment α_i^j are determined by Nash bargaining between capital owners and workers. In this cooperative setting, the share of employment will be efficient for a given unemployment benefit. Both capital and labor need not necessarily be organized in lobbies in every sector. I assume that all employees in a sector are covered by wage bargaining. This is a simplification in comparison to Matschke (2004), who divides sectors in unionized and non-unionized subsectors and integrates anti-discrimination quotas that force firms in the unionized sector to employ non-unionized workers and vice versa. This more specific setting would provide no additional insights for my comparison of the different influences of labor interests on the tariffs on intermediate and final goods. In my setting, the bargaining position of workers gets stronger the higher the unemployment benefits are. The reason is that being unemployed is the outside option for workers in wage and employment bargaining. Therefore, the government, by increasing the unemployment benefits, redistributes not only to the unemployed but also to employees. For unorganized capital owners or workers the Nash bargaining solution can be interpreted as an average wage in a subsector. The properties of the Nash Bargaining solution which drive the results of the model make sense for non-collective wage bargaining, too. Namely that wages increase with unemployment benefits and with the bargaining power of workers and that employment decreases with unemployment benefits. The next two sections provide a formal description of the Nash bargaining solution for intermediate-good and final-good sectors.

Generalized Nash Bargaining Solution for Intermediate-Good Sectors

The payments a subsector's labor force receives are the wages paid to the employed and the unemployment benefits

$$\alpha_i^I L_i^I w_i^I + (1 - \alpha_i^I) L_i^I u. \quad (1.1)$$

As only labor imposes costs on firms, the profits of capital owners in sector i are equal to

$$q_i F^{iI}(K_i^I, \alpha_i^I L_i^I) - \alpha_i^I L_i^I w_i^I. \quad (1.2)$$

With fixed tariffs and unemployment benefits the generalized Nash bargaining solution⁶ between capital owners and workers solves

$$\max_{\alpha_i^I, w_i^I} ((q_i F^{iI}(K_i^I, \alpha_i^I L_i^I) - \alpha_i^I L_i^I w_i^I)^{1-s_i^I} (\alpha_i^I L_i^I (w_i^I - u))^{s_i^I}) \quad (1.3)$$

where s_i^I is the exogenously given relative bargaining power of workers in intermediate-good production in sector i .

Using the FOCs of the maximization problem, the share of employment α_i^I is implicitly given by

$$q_i F_L^{iI}(K_i^I, \alpha_i^I L_i^I) = u \quad (1.4)$$

and wages can be expressed as

$$w_i^I = (1 - s_i^I)u + s_i^I \frac{q_i F^{iI}}{\alpha_i^I L_i^I}. \quad (1.5)$$

As one can see, the wages are a weighted sum of the unemployment benefits and the average value product of labor. The higher the bargaining power of workers, the higher is their income, as they can extract a larger part of the firms' profits in wage bargaining.

For the determination of the equilibrium tariffs and unemployment benefits in the policy game in stage one of the model, the effects of changes of all policy instruments on the welfare of capital owners and workers have to be calculated. For this purpose the following derivatives are needed:

$$\frac{\partial \alpha_i^I}{\partial q_i} = -\frac{u}{q_i^2 F_{LL}^{iI} L_i^I} > 0, \quad (1.6)$$

$$\frac{\partial(\alpha_i^I w_i^I)}{\partial q_i} = \frac{s_i^I F^{iI}}{L_i^I} + \frac{\partial \alpha_i^I}{\partial q_i} u > 0, \quad (1.7)$$

$$\frac{\partial \alpha_i^I}{\partial u} = \frac{1}{q_i F_{LL}^{iI} L_i^I} < 0. \quad (1.8)$$

Obviously, the only policy instruments which affect the specific factor returns in any intermediate-good subsector are the tariffs in this subsector and the unemployment

⁶For a discussion of wage bargaining concepts see McDonald and Solow (1981).

benefits. In the next section we will see that the situation is different in final-good subsectors.

Generalized Nash Bargaining Solution for Final-Good Sectors

The earnings of the labor force in a final-good subsector can be expressed in the same way as in intermediate-good subsectors:

$$\alpha_i^F L_i^F w_i^F + (1 - \alpha_i^F) L_i^F u. \quad (1.9)$$

But, the expression for the firms' profits in a final-good subsectors shows the main difference between final and intermediate-good sectors:

$$(p_i - \beta_i q_i) F^{iF}(K_i^F, \alpha_i^F L_i^F) - \alpha_i^F L_i^F w_i^F. \quad (1.10)$$

As the share β_i of intermediate good i is needed for the production of one unit of final good i , the price of that intermediate good influences profits in the final-good subsector. Hence, the Nash bargaining solution for wage and employment bargaining solves the following maximization problem:

$$\max_{\alpha_i^F, w_i^F} (((p_i - \beta_i q_i) F^{iF}(K_i^F, \alpha_i^F L_i^F) - \alpha_i^F L_i^F w_i^F)^{1-s_i^F} (\alpha_i^F L_i^F (w_i^F - u))^{s_i^F}) \quad (1.11)$$

where s_i^F is the exogenously given relative bargaining power of workers in final-good production in sector i .

Using the FOC, employment can still be determined by

$$(p_i - \beta_i q_i) F_L^{iF}(K_i^F, \alpha_i^F L_i^F) = u \quad (1.12)$$

and wages can be expressed as

$$w_i^F = (1 - s_i^F)u + s_i^F \frac{(p_i - \beta_i q_i) F^{iF}}{\alpha_i^F L_i^F}. \quad (1.13)$$

But, specific factor returns are now not only dependent on tariffs in the final-good subsector, but also on tariffs in the connected intermediate-good subsector. Thereby, specific factor owners in the final-good subsector get interested in tariffs on intermediate goods. They will try to influence the tariffs on the intermediate good in their sector in the policy game. Thus, for calculations of the equilibrium tariffs, two addi-

tional derivatives are needed in comparison to intermediate-good subsectors. Those derivatives determine how returns to specific factors in the final-good sectors change, if tariffs on intermediate goods change:

$$\frac{\partial \alpha_i^F}{\partial p_i} = -\frac{u}{(p_i - \beta_i q_i)^2 F_{LL}^{iF} L_i^F} > 0, \quad (1.14)$$

$$\frac{\partial(\alpha_i^F w_i^F)}{\partial p_i} = \frac{s_i^F F^{iF}}{L_i^F} + \frac{\partial \alpha_i^F}{\partial p_i} u > 0, \quad (1.15)$$

$$\frac{\partial \alpha_i^F}{\partial u} = \frac{1}{(p_i - \beta_i q_i) F_{LL}^{iF} L_i^F} < 0, \quad (1.16)$$

$$\frac{\partial \alpha_i^F}{\partial q_i} = \frac{\beta_i u}{(p_i - \beta_i q_i)^2 F_{LL}^{iF} L_i^F} < 0, \quad (1.17)$$

$$\frac{\partial(\alpha_i^F w_i^F)}{\partial q_i} = -\frac{s_i^F \beta_i F^{iF}}{L_i^F} + \frac{\partial \alpha_i^F}{\partial q_i} u < 0. \quad (1.18)$$

As $-\frac{s_i^F \beta_i F^{iF}}{L_i^F}$ is strictly negative and with consideration of (1.9), workers in final-good industries suffer from tariffs on intermediate goods used in the final-good production. The other derivatives have the same and expected signs as in the case of final-good sectors.

1.2.2 Lobby Groups and Social Welfare

The economy consists of N individuals. Each individual is either endowed with one unit of sector-specific capital or with one unit of sector-specific labor. Individuals' welfare is determined by the returns to their specific factor, their consumer surplus $s(p)$ and the per capita net revenues from taxes and subsidies $r(p, q, u)$. The first part of individuals' welfare is their consumer surplus $s(p)$. As in Grossman and Helpman (1994), individuals have quasilinear consumption preferences. It is assumed that all goods are consumed by the representative consumer. Then, the existence of a numeraire good ensures that the consumption of every final good only depends on its own price or rather tariff. Thus, the tariffs on final goods determine the consumer surplus $s(p)$

and consumption levels $d(p)$ and the impact of a tariff change on the consumer surplus can easily be calculated.

The government finances unemployment benefits and trade subsidies by lump sum taxes on a per capita basis, while the revenues from import taxation are redistributed to the individuals. Thereby, the per capita net revenue from taxes and subsidies can be expressed as

$$r(p, q, u) = \frac{1}{N} \sum_{i=1}^n [(p_i - p_i^*)[Nd_i - F^{iF}] + (q_i - q_i^*)[\beta_i F^{iF} - F^{iI}] - L_i^F(1 - \alpha_i^F)u - L_i^I(1 - \alpha_i^I)u], \quad (1.19)$$

where d_i is the per capita demand for the final good i .

The consumer surplus and the per capita net revenues from taxes and subsidies are the same for all individuals. What makes individuals different is the return to their specific factor. This return is influenced by tariffs and unemployment benefits as we saw in the last sections. As already mentioned (this will be formalized below) the government policy decision responds to lobby contributions. As the interests of owners of different factors concerning policy are divergent, individuals which own the same factor have an incentive to organize in lobbies. In the whole economy, there are two subsectors per sector and in each subsector there are two specific factors. This means that $4n$ groups of individuals with different interests exist in the economy. We assume that L of them are organized in a lobby. A lobby represents the interest of all owners of a specific factor. Hence, a lobby's welfare is the aggregated welfare of all specific factor owners. The returns to the specific factor labor are wages and unemployment benefits. Thus, we can express a union's welfare in a subsector with L_i^j workers as

$$W_i^{Lj}(p, q, u) = L_i^j \alpha_i^j w_i^j + L_i^j(1 - \alpha_i^j)u + L_i^j[r(p, q, u) + s(p)], \quad j = F, I, \quad (1.20)$$

where wages w_i^j and employment shares α_i^j are dependent on tariffs and unemployment benefits.

The returns to capital are firms' sales minus wages. The following equations already reflect the outcome of the wage bargaining in stage two. Looking first at final-good sectors, capital lobbies' welfare is determined by

$$W_i^{KF}(p, q, u) = (1 - s_i^F)[(p_i - \beta_i q_i)F^{iF} - \alpha_i^F u L_i^F] + K_i^F[r(p, q, u) + s(p)], \quad (1.21)$$

while capital lobbies' welfare in intermediate-good sectors is

$$W_i^{KI}(p, q, u) = (1 - s_i^I)[q_i F^{iI} - \alpha_i^I u L_i^I] + K_i^I[r(p, q, u) + s(p)]. \quad (1.22)$$

Social welfare is the sum over all N individuals welfare. It can be expressed as

$$\begin{aligned} W(p, q, u) = & \sum_{i=1}^n [(p_i - \beta_i q_i) F^{iF} + q_i F^{iI} + (1 - \alpha_i^F) u L_i^F + (1 - \alpha_i^I) u L_i^I] \\ & + N[r(p, q, u) + s(p)]. \end{aligned} \quad (1.23)$$

One might wonder why the unemployment benefits seem to influence the welfare in a positive way. This is not the case as they have to be financed by taxes and therefore their positive effect on labor income is fully outweighed by their negative effect on $Nr(p, q, u)$. Unemployment benefits' net effect on welfare is the reduction of production both in final and intermediate-good sectors.

Finally, it is necessary to characterize the objective function of the government. As it is standard in this branch of literature, the government cares both about collected political contributions C_i and social welfare $W(p, q, u)$. It puts higher weight on contributions than on (net-of-contributions) social welfare. Otherwise, it would be impossible for lobbies to influence the government. An additional feature of my model is, that the government weighs political contributions stronger, the more voters S_i are organized in a lobby. To model this government bias towards voters, I introduce a function $v(S_i)$ with $v'(S_i) > 0$. The intuition behind this function is quite simple. In a situation in which two lobbies offer the same amount of contributions pro and contra a tariff,⁷ a government will be biased to serve the lobby that represents more voters. This also reflects the informative effect of lobbying. Governments can learn by lobbying what the needs of their voters are and the more voters S_i signal to want some policy c , the higher is the probability that this policy is adopted. However, this bias to serve voters does not drive the main results of my model. But without it, the existence of positive unemployment benefits could hardly be explained. The lobbies offer contribution schedules $C(p, q, u)$, which announce nonnegative payments to the government for all possible policy choices. The government's objective function is then

$$G(p, q, u) = \sum_{i \in L} v(S_i) C_i(p, q, u) + a W(p, q, u) \quad a \geq 0, \quad (1.24)$$

⁷The effects on social welfare are not considered here.

where a is the government's weight on (gross-of-contributions) social welfare. With the government's objective function the objective functions of all groups which participate in the policy game have been characterized in a sufficient way. The next section describes how these objective functions determine the outcome of the policy game. The game is formalized as a menu auction, which is the standard way to solve such a policy game in the Grossman and Helpman framework.

1.2.3 Equilibrium of the Lobby Game

As in Grossman and Helpman (1994), the lobby game between the various lobbies and the government has the structure of a menu-auction problem. In contrast to Grossman and Helpman, the contribution functions do not only depend on the domestic price vector of final goods p , but additionally on the domestic price vector of intermediate goods q and the domestic unemployment benefits u . Let \mathcal{C} be the set of possible policy choices c which is defined as $\mathcal{C} := (\mathcal{P} \times \mathcal{Q} \times \mathcal{U})$, where \mathcal{P} , \mathcal{Q} and \mathcal{U} are the sets from which the government can choose p , q and u . Then, the equilibrium of the lobby game can be characterized with regard to Lemma 2 of Bernheim and Whinston (1986):

Proposition 1.1: *($\{C_i^o\}_{i \in L}, c^o$) is a subgame-perfect equilibrium of the lobby game if and only if:*

1. C_i^o is feasible for all $i \in L$;
2. c^o maximizes $\sum_{i \in L} v(S_i)C_i^o(c) + aW(c)$ on \mathcal{C}
3. c^o maximizes $W_j(c) - C_j^o(c) + \sum_{i \in L} v(S_i)C_i^o(c) + aW(c)$ on \mathcal{C} for every $j \in L$
4. for every $j \in L$ there exists a $c^j \in \mathcal{C}$ that maximizes $\sum_{i \in L} v(S_i)C_i^o(c) + aW(c)$ on \mathcal{C} such that $C_j^o(c^j) = 0$.

For a detailed discussion of this proposition the reader is referred to Grossman and Helpman (1994). For my purposes it is enough to state that their results can be carried over to the context of my model. To facilitate the analysis, differentiable contribution functions are assumed. Then, similar to equation (12) in Grossman and Helpman, the equilibrium domestic policy choice can be characterized by:

$$\sum_{i \in L} v(S_i) \nabla W_i(c^o) + a \nabla W(c^o) = 0. \quad (1.25)$$

To calculate the equilibrium policy choice, it must be examined how marginal policy changes affect social and lobby groups' welfare. In the setting of my model, we have to analyze the effects of the three different policy instruments (tariffs on final goods, tariffs on intermediate goods and unemployment benefits) on the welfare of four different kinds of lobbies (capital lobbies and unions in final and intermediate-good sectors) and on social welfare. Thereby, five derivatives are needed to calculate the equilibrium level of each policy instrument. The interested reader can find the derivatives in the appendix of this chapter.

After inserting the derivatives into the above equation, one can solve for the equilibrium tariffs on final goods, on intermediate goods and the equilibrium unemployment benefits. The next section presents the equilibrium of the policy game, explains the differences to previous results in the literature and discusses possible political implications.

1.3 Equilibrium Policy Structure

To analyze the equilibrium policy structure we start with tariffs on final goods. These tariffs have already been analyzed by various authors. We will compare my results to the results of the basic model of Grossman and Helpman (1994) and to the results of approaches, which already integrated labor interests, namely Rama and Tabellini (1998) and Matschke (2004). Furthermore, we check whether the effects of (exogenous) intermediate goods on tariffs on final goods, detected by Gawande and Bandyopadhyay (2000), are preserved in my framework. Then, we will proceed with the main contribution of my approach, the equilibrium tariffs on intermediate goods, and compare their structure to the final-good case. Finally, we will analyse the equilibrium unemployment benefits.

Proposition 1.2: *The equilibrium tariff in a final-good sector is*

$$t_i^F = \frac{I_i^{LF} v(L_i^F) s_i^F F^{iF} + I_i^{KF} v(K_i^F) (1 - s_i^F) F^{iF} - b F^{iF}}{-(a + b) M_{p_i}^{iF}} + \frac{(q_i - q_i^*) \beta_i (F_L^{iF})^2}{(p_i - \beta_i q_i) F_{LL}^{iF} M_{p_i}^{iF}} + \frac{u^2}{(p_i - \beta_i q_i)^2 F_{LL}^{iF} M_{p_i}^{iF}}, \quad (1.26)$$

where I_i^{LF} (I_i^{KF}) is equal to one if labor (capital) is organized in that subsector and equal to zero else, $M_{p_i}^{iF}$ are the net imports changes of final good i , if p_i changes, and

b is the aggregated national influence of lobbies.⁸

If we neglect the voting function v for a while, we find the equilibrium tariff of the basic Grossman and Helpman model in the first fraction of the equation. If capital owners earn all firm profits ($s_i^F = 0$), one gets exactly their expression for the equilibrium tariff. If trade unions can extract a part of firms' profit ($s_i^F > 0$), the first fraction represents the (simplified) effect of lobbying with the inclusion of trade unions as detected by Matschke (2004). Both lobby groups prefer a high tariff in their sector and therefore lobbying increases a sector's tariff as long as capital and/or labor is organized. The lobbying effects are additive and thus a tariff is largest if both capital and labor lobby. Lobbies from all other sectors oppose tariffs as they reduce their consumer surplus. Taking the voting functions into account, we observe that the tariff on a final good increases with the number of voters organized in a lobby group within that subsector, while it decreases with the number of voters organized in a lobby group outside that subsector.

The effect represented by the second fraction of the equation is caused by the demand $\beta_i F^{iF}$ for the sector-specific intermediate good in final-good production. A higher tariff in the final-good sector increases its production F^{iF} . Thereby the demand for and the import of intermediate goods grow. Thus, it is possible to enlarge tariff revenues of intermediate-good imports by increasing tariffs on final goods. The higher the tariffs on intermediate goods t_i^I are, the more attractive is this option. A similar effect can be found in Gawande and Bandyopadhyay (2000), where higher tariffs on intermediate goods increase tariffs on final goods. Finally, high unemployment benefits make a tariff on a final good more attractive, the more the tariff can ameliorate the sectoral negative effects of unemployment benefits on social welfare. Those effects of unemployment given by the last fraction of the equation are the same as in Matschke (2004).

Up to now, we have seen that my model includes all well known effects of labor market distortions and intermediate goods on tariffs on final goods. Keeping these effects in mind, we can now have a look at tariffs on intermediate goods and analyze their different structure in comparison to final-good sectors.

⁸The parameter b is in my setup not the share of individuals organized as in all other approaches. As voting functions v are introduced, it describes the aggregated national influence of lobbies. It is determined by $b = \frac{1}{N} \sum_{i=1}^n \sum_{j=F,I} (I_i^{Lj} v(L_i^j) L_i^j + I_i^{Kj} v(K_i^j) K_i^j)$.

Proposition 1.3: *The equilibrium tariff in an intermediate-good sector is*

$$\begin{aligned}
t_i^I = & \frac{I_i^{LI}v(L_i^I)s_i^IF^{iI} + I_i^{KI}v(K_i^I)(1 - s_i^I)F^{iI}}{-(a + b)M_{q_i}^{iI}} \\
& - \frac{I_i^{LF}v(L_i^F)s_i^F\beta_iF^{iF} + I_i^{KF}v(K_i^F)(1 - s_i^F)\beta_iF^{iF}}{-(a + b)M_{q_i}^{iI}} + \frac{b \cdot M^{iI}}{-(a + b)M_{q_i}^{iI}} \\
& + \frac{(p_i - p_i^*)\beta_i(F_L^{iF})^2}{(p_i - \beta_i q_i)F_{LL}^{iF}M_{q_i}^{iI}} - \frac{\beta_i u^2}{(p_i - \beta_i q_i)^2 F_{LL}^{iF}M_{q_i}^{iI}} + \frac{u^2}{q_i^2 F_{LL}^{iI}M_{q_i}^{iI}}, \quad (1.27)
\end{aligned}$$

where I_i^{LI} (I_i^{KI}) is equal to one, if labor (capital) is organized in that subsector, and equal to zero else, M^{iI} are the net imports of intermediate good i and $M_{q_i}^{iI}$ are the net imports' changes of intermediate good i , if q_i changes.

As in final-good sectors both capital and labor lobbies lobby for high tariffs in their own sector (first fraction of the equation). But, final-good producers are harmed by tariffs on their inputs and thereby have an incentive to counterlobby against the intermediate-good producers. This new effect on the equilibrium tariff in comparison to tariffs on final goods is represented by the second fraction in the equation. If all interest groups in a sector are organized, the effect of lobbying depends upon the size of the subsectors, the number of voters that are organized and the demand for the intermediate good in final-good production. It can well be that lobbying of intermediate-good producers is not sufficient to guarantee a positive tariff, as it is the case for final-good producers in their subsectors. If final-good production F^{iF} is large, needs many intermediate goods (large β_i) and represents many voters, final-good lobbies can dominate the intermediate-good lobbies.

The consumer surplus is not affected by intermediate-good prices and thereby plays no role in the tariff formation in intermediate-good sectors. But, while consumers are not harmed by tariffs on intermediate goods, they are interested in positive tariffs on imported intermediate goods to collect revenues. For the same reason, they oppose tariffs in sectors in which intermediate goods get exported. Thus, as long as tariffs are below (above) the revenue maximizing level, all lobbies try to increase (decrease) the tariff level in importing (exporting) intermediate-good sectors. This effect enters the equilibrium equation through the third fraction. While, as we saw above, tariffs in final-good subsectors have effects on tariff revenues in intermediate-good subsectors, tariffs in intermediate-good subsectors also influence tariff revenues in final-good subsectors. Higher tariffs in the intermediate-good subsector lead to less production in the dependent final-good subsector and thereby to more imports of final goods. Thereby,

the tariff revenues increase if there is a tariff on final goods (until the revenue maximizing level is reached). This effect (the fourth fraction in the equation) makes a higher tariff in the intermediate-good sector more attractive.

An interesting result describes the influence of unemployment benefits u on tariffs in intermediate-good sectors. In contrast to final-good sectors, it is ambiguous whether unemployment benefits have a positive or negative effect on tariffs on intermediate goods. On the one hand, the higher the costs of unemployment in an intermediate-good subsector are, the higher are the tariffs in that subsector. The reason is that a tariff can alleviate the cost of unemployment via higher production and employment. On the other hand, high tariffs on intermediate goods reduce the production in the dependent final-good subsector. Thus, high unemployment costs in the final-good sector make tariffs in the intermediate-good sector less attractive. The two effects induced by unemployment benefits can be found in the last two fractions in the tariff equation. Thus, the effect of unemployment benefits on intermediate-good sectors' tariffs is not uniquely predictable. On the one hand it increases employment in the intermediate-good sector, on the other hand it reduces employment in the final-good sector. Which effect dominates depends upon the sensitivity of employment to price and cost changes in both subsectors and the demand for the intermediate good in the final-good production (β_i).

To conclude the analysis of the equilibrium policy, we have a look at the economy's equilibrium unemployment benefits.

Proposition 1.4: *The unemployment benefits in equilibrium are*

$$u = \frac{\sum_{i=1}^n \sum_{j=F,I} L_i^j (I_i^{Lj} v(L_i^j) (1 - \alpha_i^j s_i^j) - I_i^{Kj} v(K_i^j) \alpha_i^j (1 - s_i^j) - b(1 - \alpha_i^j))}{-(a + b) \sum_{i=1}^n \left(\frac{(p_i^* - \beta_i q_i^*)}{(p_i - \beta_i q_i)^2 F_{LL}^{iF}} + \frac{q_i^*}{q_i^2 F_{LL}^{iI}} \right)}$$

Lobbying of labor unions has a positive influence on unemployment benefits as the first summand in the numerator shows. Both labor unions in the final-good sectors and in intermediate-good sectors benefit from unemployment benefits. The larger the labor force in the organized sectors, the larger are those benefits. But, the higher the quota of employment α_i^j and the larger the bargaining power in wage bargaining of workers s_i^j , the smaller is the employees' interest in unemployment benefits. The rationale for the latter result is that workers with a strong position in wage bargaining

do not need the outside option of unemployment benefits as much as workers with a weak position. The capital owners lobby against unemployment benefits (the second summand in the numerator). The larger the capital owners power in wage bargaining, $1 - s_i^j$, the stronger are their incentives to prevent unemployment benefits and therefore their lobbying. All lobby groups have a common interest to reduce unemployment benefits, because they have to finance the benefits via per-capita taxes. This lobbying of all organized interest groups results in the third summand in the numerator. The larger the social costs of unemployment are, the smaller are unemployment benefits in equilibrium. The social costs of unemployment are represented by the denominator in the equilibrium equation. Higher tariffs on consumption goods (included in p_i) reduce the social costs of unemployment benefits and thereby increase equilibrium unemployment benefits. For tariffs on intermediate goods (included in q_i) the result is ambiguous, as they are mainly a redistribution from final-good to intermediate-good producers. This makes clear why statements on interactions between tariffs and labor market distortions have to be treated carefully. Rama and Tabellini (1998) suggest that it is possible to induce countries to reduce their labor market distortions by reducing their tariff barriers. This conclusion hinges on the absence of intermediate goods. With intermediate-good sectors it is not possible anymore to make such general predictions. A (selective) reduction of tariffs could have no influence on labor market distortions or even increase distortions.

1.4 Conclusion

My approach is the first that explains the tariff structure in intermediate-good sectors using the seminal political economy framework for tariff formation by Grossman and Helpman (1994). My approach turned out to be fruitful, as important differences in comparison to tariff formation in final-good sectors could be identified. As empirics suggest, tariffs on final goods tend to be higher than tariffs on intermediate goods. Additional insights in tariff formation are gained by the consideration of labor interests. They have a different effect on tariffs in intermediate-good sectors in comparison to final-good sectors. As already shown by Matschke (2004) and Rama and Tabellini (1998), labor market distortions increase tariffs in final-good sectors. In contrast to final-good sectors this chapter shows that for intermediate-good sectors no unambiguous effects of labor market distortions are observable. It depends on the industry structure, especially on the degree of dependency of the national production

on the intermediate good, in which direction labor market distortions push tariffs in intermediate-good sectors. Otherwise, tariffs influence the optimal level of labor market distortions. While tariffs on final goods make labor market distortions more attractive by reducing their social costs, this does not hold for tariffs on intermediate goods. They reduce final-good production and can thereby increase overall unemployment. Thus, it is not necessarily possible to put pressure on labor market distortions by reducing tariffs as Rama and Tabellini suggest.

It remains for future research to examine whether the identified pattern of tariff formation can be confirmed by empirics. Testable results of my model are the following: The more interest groups are organized in the whole economy, the higher contributions should be observable in final-good sectors. In intermediate-good sectors, the level of contributions should be larger, the better organized the dependent final-good producers are. In sectors in which all interest groups are organized, higher tariffs should prevail on final goods in comparison to intermediate goods. In a country with large labor market distortions, tariffs on final goods should be higher than in countries with more liberalized labor markets. This effect should be weaker or even absent in intermediate-good sectors.

Furthermore, it would be interesting to know how robust these results are to the internationalization of lobbying. It could well be that international lobbying has different effects on tariffs on final in comparison to intermediate goods. This would e.g. be the case, if it is easier for firms to lobby internationally than it is for consumers. Changes in the equilibrium tariff structure could also occur if different organizational forms are reflected in the tariff formation. In sectors in which a large share of intermediate-good producers is vertically integrated, the policy game between final and intermediate-good producers should be less intensive and thus contributions smaller. In those sectors, the focus of the policy game should shift from national redistribution conflicts between final- and intermediate-good producers to international redistribution conflicts between suppliers of the same intermediate good. A final-good producer who owns its input supplier could even be interested in a positive tariff on his input to protect his supplier against import penetration.

1.5 Appendix

Derivatives of welfare with respect to unemployment benefits

$$\frac{\partial W}{\partial u} = u \sum_{i=1}^n \left(\frac{(p_i^* - \beta_i q_i^*)u}{(p_i - \beta_i q_i)^2 F_{LL}^{iF}} + \frac{q_i^* u}{q_i^2 F_{LL}^{iI}} \right)$$

$$\frac{\partial W_i^{LF}}{\partial u} = L_i^F (1 - \alpha_i^F s_i^F) + \frac{L_i^F}{N} \cdot \frac{\partial r(p, q, u)}{\partial u}$$

where

$$\frac{\partial r(p, q, u)}{\partial u} = \sum_{j=1}^n \left(\frac{(p_j^* - \beta_j q_j^*)u}{(p_j - \beta_j q_j)^2 F_{LL}^{jF}} + \frac{q_j^* u}{q_j^2 F_{LL}^{jI}} - L_j^F (1 - \alpha_j^F) - L_j^I (1 - \alpha_j^I) \right)$$

$$\frac{\partial W_i^{KF}}{\partial u} = -L_i^F \alpha_i^F (1 - s_i^F) + \frac{K_i^F}{N} \cdot \frac{\partial r(p, q, u)}{\partial u}$$

$$\frac{\partial W_i^{LI}}{\partial u} = L_i^I (1 - \alpha_i^I s_i^I) + \frac{L_i^I}{N} \cdot \frac{\partial r(p, q, u)}{\partial u}$$

$$\frac{\partial W_i^{KI}}{\partial u} = -L_i^I \alpha_i^I (1 - s_i^I) + \frac{K_i^I}{N} \cdot \frac{\partial r(p, q, u)}{\partial u}$$

Derivatives of welfare with respect to tariffs on intermediate goods

$$\frac{\partial W}{\partial q_j} = (q_j - q_j^*) M_j^{I'}(q_j) - \frac{(p_j - p_j^*) \beta_j (F_L^{jF})^2}{(p_j - \beta_j q_j) F_{LL}^{jF}} - \frac{\beta_j u^2}{(p_j - \beta_j q_j)^2 F_{LL}^{jF}} - \frac{u^2}{q_j^2 F_{LL}^{jI}}$$

$$\frac{\partial W_i^{LF}}{\partial q_j} = -I_{ij} s_i^F \beta_i F^{iF} + \frac{L_i^F}{N} \cdot \frac{\partial r(p, q, u)}{\partial q_j}$$

where

$$\frac{\partial r(p, q, u)}{\partial q_j} = -\frac{(p_j - p_j^*)\beta_j(F_L^{jF})^2}{(p_j - \beta_j q_j)F_{LL}^{jF}} - \frac{\beta_j u^2}{(p_j - \beta_j q_j)^2 F_{LL}^{jF}} - \frac{u^2}{q_j^2 F_{LL}^{jI}} + (q_j - q_j^*)M_j^{I'}(q_j) + M_j(q_j)$$

$$\frac{\partial W_i^{KF}}{\partial q_j} = -I_{ij}(1 - s_i^F)\beta_i F^{iF} + \frac{K_i^F}{N} \cdot \frac{\partial r(p, q, u)}{\partial q_j}$$

$$\frac{\partial W_i^{LI}}{\partial q_j} = I_{ij}s_i^I F^{iI} + \frac{L_i^I}{N} \cdot \frac{\partial r(p, q, u)}{\partial q_j}$$

$$\frac{\partial W_i^{KI}}{\partial q_j} = I_{ij}(1 - s_i^I)F^{iI} + \frac{K_i^I}{N} \cdot \frac{\partial r(p, q, u)}{\partial q_j}$$

Derivatives of welfare with respect to tariffs on final goods

$$\frac{\partial W}{\partial p_j} = (p_j - p_j^*)M_j^{F'}(p_j) - \frac{(q_j - q_j^*)\beta_j(F_L^{jF})^2}{(p_j - \beta_j q_j)F_{LL}^{jF}} - \frac{u^2}{(p_j - \beta_j q_j)^2 F_{LL}^{jF}}$$

$$\frac{\partial W_i^{LF}}{\partial p_j} = I_{ij}s_i^F F^{iF} + \frac{L_i^F}{N} \cdot \frac{\partial(r(p, q, u) + s(p))}{\partial p_j}$$

where

$$\frac{\partial(r(p, q, u) + s(p))}{\partial p_j} = (p_j - p_j^*)M_j^{F'}(p_j) - \frac{(q_j - q_j^*)\beta_j(F_L^{jF})^2}{(p_j - \beta_j q_j)F_{LL}^{jF}} - \frac{u^2}{(p_j - \beta_j q_j)^2 F_{LL}^{jF}} - F^{jF}$$

$$\frac{\partial W_i^{KF}}{\partial p_j} = I_{ij}(1 - s_i^F)F^{iF} + \frac{K_i^F}{N} \cdot \frac{\partial(r(p, q, u) + s(p))}{\partial p_j}$$

$$\frac{\partial W_i^{LI}}{\partial p_j} = \frac{L_i^I}{N} \cdot \frac{\partial(r(p, q, u) + s(p))}{\partial p_j}$$

$$\frac{\partial W_i^{KI}}{\partial p_j} = \frac{K_i^I}{N} \cdot \frac{\partial(r(p, q, u) + s(p))}{\partial p_j}$$

Chapter 2

The Risk of Vertical Specialization for Strategic Trade Policy

2.1 Introduction

Export subsidies on final goods can give domestic exporters a strategic advantage over their foreign competitors. With the support of a subsidy, domestic firms increase their export volume and thereby gain market share and presumably profits in third markets. Brander and Spencer (1985) have shown in their seminal paper that in case of a domestic and a foreign firm acting as Cournot competitors the optimal policy consists of a subsidy. Eaton and Grossman (1986) and Dixit (1984) have qualified this result as they pointed out that with increasing competition the incentive to subsidize vanishes and the optimal policy changes to a tax. Taking these approaches as a starting point, a branch of the economic literature analyzed the optimal strategic trade policy on final goods from a variety of perspectives.¹

But, in recent years the focus of research has changed: As they play an increasingly important role in world trade especially for industrialized countries, there is a growing literature on the importance of intermediate goods for strategic trade policy.² Bernhofen (1997) introduces a vertical structure into the model of Brander and Spencer (1985). In his approach, a foreign monopolist supplies inputs that both final-good pro-

¹See, e.g., Spencer and Brander (1983), Davidson (1984), Dixit and Kyle (1985), Carmichael (1987), Gruenspecht (1988), Rotemberg and Saloner (1989), Bagwell and Staiger (1992, 1994), and Qiu (1994).

²See, e.g., Chang and Kim (1991), Spencer and Jones (1991, 1992), Rodrik and Yoon (1995), Bernhofen (1997), Ishikawa and Lee (1997), Ziss (1997), Ishikawa and Spencer (1999), Chang and Sugeta (2004), and Nese and Straume (2005).

ducing firms need for their production. Thereby, the incentive to subsidize final-good production is reduced as a subsidy not only shifts profits horizontally, but also vertically. If the intermediate-good supplier can price discriminate between the final-good producers, the optimal policy even changes to a tax on final-good production. Ishikawa and Spencer (1999)³ analyze the role of intermediate goods in a model in which an intermediate and a final good are produced in two countries. With the assumption of Cournot competition, an export subsidy aimed at shifting rents from foreign to domestic final-good producers may also shift rents to foreign intermediate-good suppliers. Thus, as long as a subsidy increases the price of the intermediate good, the desirability of a subsidy is reduced if the intermediate-good producers are foreign. With a purely domestic intermediate-good industry the argument for a subsidy is strengthened because a subsidy reduces the efficiency loss induced by 'double marginalization'. Ishikawa and Spencer also analyze the optimal trade policy toward the intermediate good. They do so in a framework in which the domestic intermediate-good suppliers only serve the domestic final-good producers. Thus, there will always be a subsidy as long as it shifts profits horizontally in favor of the domestic country and reduces the intermediate-good price.

The two mentioned approaches (and the literature on intermediate goods and strategic trade policy in general) have in common that the industry distribution over countries is symmetric. It has not yet been a focus of research how strategic trade policy changes, if there is one country where both intermediate-good and final-good industries are located and if there are two countries where only one (an intermediate- or a final-good) industry is located. But, I think that this is a very interesting case, as there is a trend in industrialized countries to concentrate on the production of final goods and to outsource the production of intermediate goods.⁴ While there are many good reasons to do so (especially from the firms' point of view), there is a risk from the perspective of strategic trade policy.⁵ With the consideration of intermediate goods, as we have discussed above, the vertical rent shifting motive plays an important role in strategic trade policy. Thus, a country that has both an intermediate-good and a final-good industry has a strategic advantage over the vertically specialized countries, as it has the possibility to use taxes or subsidies towards both industries. If for example its final-good industry holds a large market share, it can subsidize intermediate-good

³and in a similar approach Ishikawa and Lee (1997).

⁴For empirical evidence on vertical specialization and its influence on world trade see Hummels, Ishii and Yi (2001) and Chen, Kondratowicz and Yi (2005).

⁵For theoretic analysis of international outsourcing see Feenstra and Hanson (1996), Arndt (1997), and Deardorff (2001). For the analysis of a firm's decision see Spencer and Raubitschek (1996).

production very aggressively, since most of the profits shifted vertically add to its own welfare. The aim of this chapter is to analyze how strong the strategic advantage of the non-specialized country is and how its policy affects the specialized countries' policies. To do so, we build a model in which all countries are engaged in strategic trade policy. Thereby, we can directly compare the direction and intensity of trade policy in the specialized and non-specialized countries. To enrich the analysis, we consider asymmetric costs of production both in the intermediate-good and the final-good industries. As a benchmark case, we additionally analyze a framework in which industries are symmetrically distributed over countries. There, each of the four industries is located in a different country. The benchmark case makes it easier to identify the effects of the asymmetric industry distribution in my main case.

We show some interesting interactions between the non-specialized country's policy in the intermediate- and final-good sector. Maximizing its intermediate-good producer's profits alone, a country would always subsidize its production. But, if increased intermediate-good prices hurt the foreign more than the domestic final-good producer, it can be that the non-specialized country taxes its intermediate-good production. The maximization of the intermediate-good producer's profits also influences the policy in the final-good sector. Without the inclusion of intermediate-good profits, the subsidization of final-good production increases with the relative efficiency of domestic in comparison to foreign final-good production. The opposite can be true if domestic intermediate-good profits are taken into account, because more profits can be shifted vertically in case of an inefficient final-good production. Hence, the subsidization of final-good production can be decreasing with the relative efficiency of production, if the domestic intermediate-good producer captures a large share of the profits shifted vertically. In general, we can show that a country with both kinds of industries acts more aggressively in strategic trade policy than vertically specialized countries.

The rest of the chapter proceeds as follows. Section 2.2 describes the model and the market equilibrium in the intermediate- and final-good market. We analyze the policy equilibria of the two cases described above in section 2.3. In section 2.4 we finally conclude.

2.2 Model Structure and Market Equilibrium

We formalize a situation in which two monopolists located in two different countries compete in an internationally integrated intermediate-good market.⁶ With an internationally integrated intermediate-good market not only the domestic final-good producers benefit from a subsidy (if it reduces intermediate-good prices), but also the foreign final-good producers. Thereby, the policy toward the intermediate good gets more interesting and there are richer interactions between the policies toward intermediate and final goods. The assumption of an internationally integrated intermediate-good market seems to be realistic as international trade agreements prohibit the price discrimination of foreign final-good producers by tariffs between a growing number of countries. The homogeneous intermediate good is needed for the production of a homogeneous final good. The final good is also produced by two monopolists in two different countries. The final good producing monopolists compete in a foreign consumer market. There is Cournot competition in both final- and intermediate-good markets. We assume that the final good producing firms take the intermediate-good price as given when committing to an output quantity. Thereby the intermediate-good producers get a first-mover advantage.

Strategic trade policy is introduced by allowing policy makers to impose taxes or subsidies on the production of each monopolist. Thereby policy makers can shift profits both horizontally and vertically. In the section on policy equilibria we will analyze two cases concerning the industry distribution over countries: In the first case each monopolist is located in a different country, i.e. there are overall four countries. The second case is the main contribution of this chapter. There one intermediate good and one final good producing monopolist are located in one country, while the other two monopolists are located in a second and a third country.

The modeled game has a three-stage structure. In the first stage the governments simultaneously and independently determine the taxes (subsidies) on intermediate- and final-good production. In the second stage the intermediate good producing monopolists choose the quantities they want to supply to the intermediate-good market. In the third and final stage the final-good producers choose the quantities they supply to the

⁶The internationally integrated intermediate-good market is modeled as it has similarly been done by Nese and Straume (2005). They analyze a three-country case, in which in two countries intermediate-good industries are located and in a third country a final-good industry is located. While my model is based on their model, the focus of their research is very different. They mainly analyze the influence of the degree of competitiveness in the intermediate- and final-good market on strategic trade policy.

consumer market given the supply in the intermediate-good market. In the following we will solve this game by backward induction.

2.2.1 The Final-Good Market

The behavior of the firms is modeled as a Cournot duopoly. Both firms produce a homogeneous final good. The price of the final good is determined by the inverse demand curve

$$p = a - Y, \quad (2.1)$$

where $Y := \sum_{i=1}^2 y_i$ is the total output supplied by the two final good producing monopolists. For simplicity the demand curve is assumed to be linear. We assume that the monopolists differ in their production efficiency and need α_i units of the intermediate good to produce one unit of the final good. This asymmetric need for inputs is a very important feature of my model. Therewith, in equilibrium it can well be that the less efficient final-good producer demands more inputs than the more efficient final-good producer, even if the latter holds a larger market share. In a country in which both an intermediate- and a final-good industry are located, a subsidy on final-good production can then be more attractive the less efficient the own final-production is (to increase the profits of the intermediate-good industry). This effect is absent in other strategic trade policy models with intermediate goods in which α_i is normalized to one.⁷ The price of the intermediate good is denoted by w . Each government can impose a tax or grant a subsidy t_i^F on its final-good production. The profits of the final good producing monopolists can then be written as

$$\pi_i^F = (p - \alpha_i w - t_i^F) y_i, \quad i = 1, 2. \quad (2.2)$$

In the Cournot-Nash equilibrium the outputs of the firms are given by

$$y_i = \frac{a - (2\alpha_i - \alpha_{-i})w + t_{-i}^F - 2t_i^F}{3}, \quad i = 1, 2, \quad (2.3)$$

and the overall supply of the final good sums up to

$$Y = \sum_i^2 y_i = \frac{2a - (\alpha_1 + \alpha_2)w - (t_1^F + t_2^F)}{3}. \quad (2.4)$$

⁷See, e.g., Spencer and Jones (1992), Bernhofen (1997), and Ishikawa and Spencer (1999).

Knowing the firms' behavior in the final-good market one can analyze how the intermediate-good firms behave in the second stage of the game.

2.2.2 The Intermediate-Good Market

Given the behavior of the final good producing firms, the monopolists producing the intermediate good face the following demand for their goods:

$$\begin{aligned} X &= \sum_i^2 \alpha_i y_i \\ &= \frac{(\alpha_1 + \alpha_2)a + 2(\alpha_1\alpha_2 - \alpha_1^2 - \alpha_2^2)w - (2\alpha_1 - \alpha_2)t_1^F - (2\alpha_2 - \alpha_1)t_2^F}{3}. \end{aligned} \quad (2.5)$$

Given the demand, one can easily calculate the inverse demand function determining the price of the intermediate good:

$$w = \frac{(\alpha_1 + \alpha_2)a - (2\alpha_1 - \alpha_2)t_1^F - (2\alpha_2 - \alpha_1)t_2^F - 3X}{2(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)}, \quad (2.6)$$

where $X := \sum_{j=1}^2 x_j$ is the total output supplied by the intermediate-good producers. The intermediate-good producers face constant marginal costs of production c_j which vary over the countries. Governments can impose a tax or grant a subsidy t_j^I on the production of the intermediate good. The profits of the firms producing intermediate goods are then given by

$$\pi_j^I = (w - t_j^I - c_j)x_j, \quad j = 1, 2. \quad (2.7)$$

The optimal outputs in the Cournot-Nash equilibrium of the monopolists producing intermediate goods can now easily be calculated and are given by

$$\begin{aligned} x_j &= \frac{(\alpha_1 + \alpha_2)a - \sum_i^2 (2\alpha_i - \alpha_{-i})t_i^F + (\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)}{9} \\ &\quad \frac{(-4(t_j^I + c_j) + 2(t_{-j}^I + c_{-j}))}{.} \end{aligned} \quad (2.8)$$

In my linear framework, the taxes on intermediate-good production have an unambiguous effect on the firms' outputs. The domestic intermediate-good output x_j decreases with a domestic tax t_j^I , while it increases with a foreign tax t_{-j}^I . For the taxes t_i^F on final-good production the results are not that simple. In most cases the outputs x_j de-

crease with taxes on final-good production. But, if one country has a strong efficiency advantage in final-good production ($2\alpha_i < \alpha_{-i}$), the outputs x_j of the intermediate good are increasing with a tax imposed by that country. This effect is caused by the less efficient monopolist's high demand for intermediate goods. Since its market share is increased by a tax on foreign production, this has a positive effect on the demand for intermediate goods. This effect overcompensates the negative effect on the demand that such a tax causes via a reduced final-good production.

The overall production of the intermediate good is then given by

$$\begin{aligned} X &= \sum_{j=1}^2 x_j \\ &= \frac{2(\alpha_1 + \alpha_2)a - 2\sum_i^2(2\alpha_i - \alpha_{-i})t_i^F - 2(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)\sum_j^2(t_j^I + c_j)}{9}. \end{aligned} \quad (2.9)$$

Knowing the behavior of all firms involved in the game it is now possible to calculate the equilibrium prices of the two kinds of goods and the equilibrium profits of the firms.

2.2.3 Market Equilibrium

In equilibrium the price of the intermediate good is given by

$$w = \frac{(\alpha_1 + \alpha_2)a - \sum_i^2(2\alpha_i - \alpha_{-i})t_i^F + 2(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)\sum_j^2(t_j^I + c_j)}{6(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)}. \quad (2.10)$$

As one would expect, the price of the intermediate good increases with the taxes on intermediate-good production t_j^I . If the difference in the efficiency of final-good production is not too large ($2\alpha_1 > \alpha_2$ and $2\alpha_2 > \alpha_1$), the price is decreasing with the taxes on final-good production t_i^F . The subsidization of final-good production to gain market shares in the consumer market has in that case the negative effect of shifting profits partially to the intermediate-good producers. If one country has a strong efficiency advantage in final-good production ($2\alpha_i < \alpha_{-i}$), the price of the intermediate good increases with a tax imposed by that country. In this case this country can subsidize its final-good production and simultaneously reduce the price of its input. Then, this country's government obviously has a strong strategic advantage over the competing country's government.

Given the price of the intermediate good, one can calculate the equilibrium outputs

of the final good:

$$y_i = \frac{(4\alpha_i^2 + 7\alpha_{-i}^2 - 7\alpha_1\alpha_2)a - (8\alpha_i^2 + 11\alpha_{-i}^2 - 8\alpha_1\alpha_2)t_i^F + (4\alpha_1^2 + 4\alpha_2^2 - \alpha_1\alpha_2)t_{-i}^F}{18(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)} - \frac{2(2\alpha_i - \alpha_{-i})(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2) \sum_j^2 (t_j^I + c_j)}{18(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)}. \quad (2.11)$$

The outputs y_i decrease with the tax t_i^F on the output itself and increases with the tax t_{-i}^F on the competing monopolist's production. The taxes t_j^I on and costs c_j of intermediate-good production tend to decrease the outputs in the final-good sector as they make their inputs more expensive. Only if one final-good producer is far more efficient than its rival ($2\alpha_i < \alpha_{-i}$), its output y_i increases with taxes t_j^I on and costs c_j of intermediate-good production. In that case, its rival suffers that much from a higher input price (induced by higher taxes or costs), that the very efficient producer strongly increases its market shares if the input price rises. This effect then dominates the output reducing effect of increasing input prices.

The overall output of the final good is then given by

$$Y = \sum_{i=1}^2 y_i = \frac{(11\alpha_1^2 + 11\alpha_2^2 - 14\alpha_1\alpha_2)a - \sum_i^2 (4\alpha_i^2 + 7\alpha_{-i}^2 - 7\alpha_1\alpha_2)t_i^F}{18(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)} - \frac{2(\alpha_1 + \alpha_2)(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2) \sum_j^2 (t_j^I + c_j)}{18(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)}. \quad (2.12)$$

The overall output Y of the final good unambiguously decreases with all taxes t_j^I and t_i^F and with the costs c_j of intermediate-good production.

Inserting the overall output in (2.1) allows to calculate the final-good price in equilibrium:

$$p = \frac{(7\alpha_1^2 + 7\alpha_2^2 - 4\alpha_1\alpha_2)a + \sum_i^2 (4\alpha_i^2 + 7\alpha_{-i}^2 - 7\alpha_1\alpha_2)t_i^F}{18(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)} + \frac{2(\alpha_1 + \alpha_2)(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2) \sum_j^2 (t_j^I + c_j)}{18(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)}. \quad (2.13)$$

It is easy to see that the price p of the final good increases both with taxes t_j^I on intermediate and t_i^F on final goods.

Knowing the equilibrium outputs and prices, we can finally calculate the equilibrium profits of the intermediate- and final-goods producers. The equilibrium profits in the

intermediate-good sector are

$$\pi_j^I = \frac{((\alpha_1 + \alpha_2)a - \sum_i^2 (2\alpha_i - \alpha_{-i})t_i^F + (\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2))}{54(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)} \frac{(-4(t_j^I + c_j) + 2(t_{-j}^I + c_{-j}))^2}{(2.14)}$$

The equilibrium profits π_j^I decrease with a tax t_j^I imposed on the monopolist's production and increases with a tax t_{-j}^I imposed on the rival's production. In most cases taxes t_i^F on final-good production decrease profits in the intermediate-good sector. But, as already discussed for the equilibrium intermediate-good price, if one final-good producer is far more efficient than its competitor ($2\alpha_i < \alpha_{-i}$), a tax t_i^F on its production raises the profits of intermediate-good producers. This result is the first major difference from the results of Ishikawa and Spencer (1999). In their model a subsidy applied to final-good production always raises the profits of intermediate-good producers.⁸ The reason is the separated intermediate-good markets in their model, that neglect the effects a subsidy on final-good production has on the intermediate-good market via the reduced final-good production of the foreign competitor.

The profits of the final good producing firms can be expressed as

$$\pi_i^F = \frac{((4\alpha_i^2 + 7\alpha_{-i}^2 - 7\alpha_1\alpha_2)a - (8\alpha_i^2 + 11\alpha_{-i}^2 - 8\alpha_1\alpha_2)t_i^F + (4\alpha_1^2 + 4\alpha_2^2 - \alpha_1\alpha_2)t_{-i}^F)}{324(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)^2} \frac{-2(2\alpha_i - \alpha_{-i})(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2) \sum_j^2 (t_j^I + c_j)^2}{(2.15)}$$

Similarly as in the intermediate-good sector, firms' profits π_i^F in the final-good sector decrease with taxes t_i^F on their own production, while they increase with taxes t_{-i}^F on their foreign competitor's production. Again, in most cases the profits decrease with taxes t_j^I on and costs c_j of intermediate-good production. Only if one final-good producer is far more efficient ($2\alpha_i < \alpha_{-i}$) than its foreign rival, his profits increase with taxes on and costs of intermediate-good production.

Now that we have analyzed the firms' behavior in the second and third stage of my model, we can proceed by analyzing the optimal strategic trade policy in the first stage of my model in the next section.

⁸In the case of linear demand.

2.3 Policy Equilibria

In this section we analyze the government's optimal policy in stage one of the trade policy game given the behavior of the firms in stage two and three. The governments in the countries act simultaneously and maximize their national welfare. The welfare consists out of firm profits and tax revenues. We differentiate two cases. In the first case, which serves as a benchmark case, each monopolist is located in a different country. Hence, there are four governments that play against each other in the trade policy game. In the second case, which is the main contribution of my approach, there is an asymmetric industry distribution over countries. On the one hand, there is one country where both an intermediate and a final good producing monopolist exist. On the other hand, there are two countries which are specialized in the production of either intermediate or final goods. The country with both kinds of industries probably has a strategic advantage in trade policy, because it can shift profits from one of its industries to the other. We want to analyze how big this advantage is and how much it depends on the relative efficiency of production both in the intermediate- and final-good sector.

2.3.1 Trade Policy with a Symmetric Industry Distribution

Four independently and simultaneously acting governments maximize their national welfare. The welfare consist out of firm profits and tax revenues. In the countries with an intermediate-good producer the welfare is given by

$$W_j^I = \pi_j^I + t_j^I x_j, \quad j = 1, 2, \quad (2.16)$$

while the welfare in the countries with final-good production is determined by

$$W_i^F = \pi_i^F + t_i^F y_i, \quad i = 1, 2. \quad (2.17)$$

Best response functions. Given the results from the market equilibrium, one can easily calculate each country's best response function depending on the other governments' policy. We start with the analysis of the best response functions for the intermediate good producing countries:

$$t_j^I = -\frac{(\alpha_1 + \alpha_2)a - \sum_i^2 (2\alpha_i - \alpha_{-i})t_i^F + 2(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)(t_{-j}^I + c_{-j} - 2c_j)}{8(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)}. \quad (2.18)$$

The intermediate good producing countries subsidize their production.⁹ Their main incentive is to increase their market share in the intermediate-good market. The larger the size a of the intermediate-good market is, the stronger is the incentive to subsidize. Taxes on final-good production t_i^F tend¹⁰ to reduce the intermediate-good subsidies¹¹ as they reduce the final-good production and thereby decrease the demand for intermediate-goods. A tax of the other intermediate good producing country t_{-j}^I increases the incentive to subsidize, as it makes the subsidy more effective. As in all standard strategic trade policy models, the subsidy increases with the competing countries marginal cost of production and decreases with the own marginal cost of production. The impact of the own cost of production is twice as big as the impact of the foreign cost of production.

The best response functions for the countries with final-good production are

$$t_i^F = -\frac{(2\alpha_{-i}^2 - \alpha_i^2 + \alpha_1\alpha_2)((4\alpha_i^2 + 7\alpha_{-i}^2 - 7\alpha_1\alpha_2)a + (4\alpha_1^2 + 4\alpha_2^2 - \alpha_1\alpha_2)t_{-i}^F - 2(2\alpha_i^3 - \alpha_{-i}^3 + 3\alpha_1\alpha_2(\alpha_{-i} - \alpha_i))(t_1^I + t_2^I + c_1 + c_2))}{(8\alpha_i^2 + 11\alpha_{-i}^2 - 8\alpha_1\alpha_2)(10\alpha_i^2 + 7\alpha_{-i}^2 - 10\alpha_1\alpha_2)}. \quad (2.19)$$

In the final good producing countries it is ambiguous whether the government uses a tax or a subsidy. In most cases they use a subsidy to increase their market share in the consumer market. But if country i is very unproductive in comparison to country $-i$ ($\alpha_i > 2\alpha_{-i}$), it uses a tax instead of a subsidy. In that case the incentive to shift rents vertically and to collect tax revenues dominates the incentive to shift rents horizontally. A tax t_{-i}^F on the production of the competing country's monopolist increases both in the case of a tax and of a subsidy the level of the trade policy in the final good producing countries. The taxes t_j^I and the production costs c_j in the

⁹In the following, if not stated otherwise, we take the assumption that the size of the final-good market is sufficiently large in comparison to the marginal production costs of the intermediate good ($a \gg c_j$, $j = 1, 2$) to ensure that a positive or negative derivative of a tax with respect to a decides whether the tax is positive or negative.

¹⁰If country i 's final-good production is more than twice as efficient as country $-i$'s final-good production ($2\alpha_i < \alpha_{-i}$), a tax of that country would increase the demand for intermediate goods. The reason is that such a tax would increase the market share of the less productive country that needs far more intermediate goods for its production.

¹¹In the following we always speak about absolute values if we say a tax or subsidy is reduced or increased.

intermediate good producing countries have the same impact on the taxes in the final good producing countries. In most cases these variables reduce the taxes or subsidies in the final good producing countries as they reduce the profits that can be earned by the final-good producers. Only if country i is more than twice as productive as country $-i$ ($\alpha_{-i} > 2\alpha_i$), the taxes and the production costs in the intermediate good producing countries increase the tax or subsidy in country i . In that case an increase in one of these variables reduces the profits of the competing monopolist that much, that it improves the situation of the monopolist in country i and makes its government act more aggressively in trade policy.

Equilibrium taxes. With the best response functions given in (2.18) and (2.19) we can easily calculate the equilibrium taxes for simultaneously acting governments. The equilibrium taxes on intermediate-good production are

$$t_j^I = - \frac{(168(\alpha_1^5 + \alpha_2^5) - 78(\alpha_1^4\alpha_2 + \alpha_1\alpha_2^4) + 141(\alpha_1^3\alpha_2^2 + \alpha_1^2\alpha_2^3))a + (944(\alpha_1^6 + \alpha_2^6) - 2(1160(\alpha_1^6 + \alpha_2^6) - 3624(\alpha_1^5\alpha_2 + \alpha_1\alpha_2^5) + 7302(\alpha_1^4\alpha_2^2 + \alpha_1^2\alpha_2^4) - 8633\alpha_1^3\alpha_2^3) - 2928(\alpha_1^5\alpha_2 + \alpha_1\alpha_2^5) + 5820(\alpha_1^4\alpha_2^2 + \alpha_1^2\alpha_2^4) - 6860\alpha_1^3\alpha_2^3)c_{-j} - (1376(\alpha_1^6 + \alpha_2^6) - 4320(\alpha_1^5\alpha_2 + \alpha_1\alpha_2^5) + 8784(\alpha_1^4\alpha_2^2 + \alpha_1^2\alpha_2^4) - 10406\alpha_1^3\alpha_2^3)c_j}{}, \quad (2.20)$$

which is negative, i.e. the intermediate good producing countries always subsidize their production.¹² The more similar and smaller the costs in the final-good market (similar and small α_i 's) are, the larger is the incentive to subsidize the intermediate good (see figure 2.1).¹³ As one would expect, a country's subsidy increases with the marginal production cost of the other country's monopolist c_{-j} and is decreasing with the cost of its own monopolist c_j . The (absolute) effect of the own cost is about fifty percent higher than the effect of the foreign cost.¹⁴ My result can be compared to a result of Nese and Straume (2005). They also show that both intermediate good producing countries subsidize their production, if there is a monopoly in each country. As in both models the countries simply compete for market share in the integrated intermediate-good market, this is not a surprising result. We proceed with the analysis of the taxes on final-good production.

¹²The derivative of t_j^I with respect to a is strictly negative.

¹³The derivative of t_j^I with respect to a has, e.g. its maximum on $[0.5, 1.5]^2$ at $\alpha_1 = \alpha_2 = 0.5$ and increases if the larger of the α_i 's gets reduced.

¹⁴The derivatives of t_j^I with respect to the c_j s hardly vary with the α_i 's.

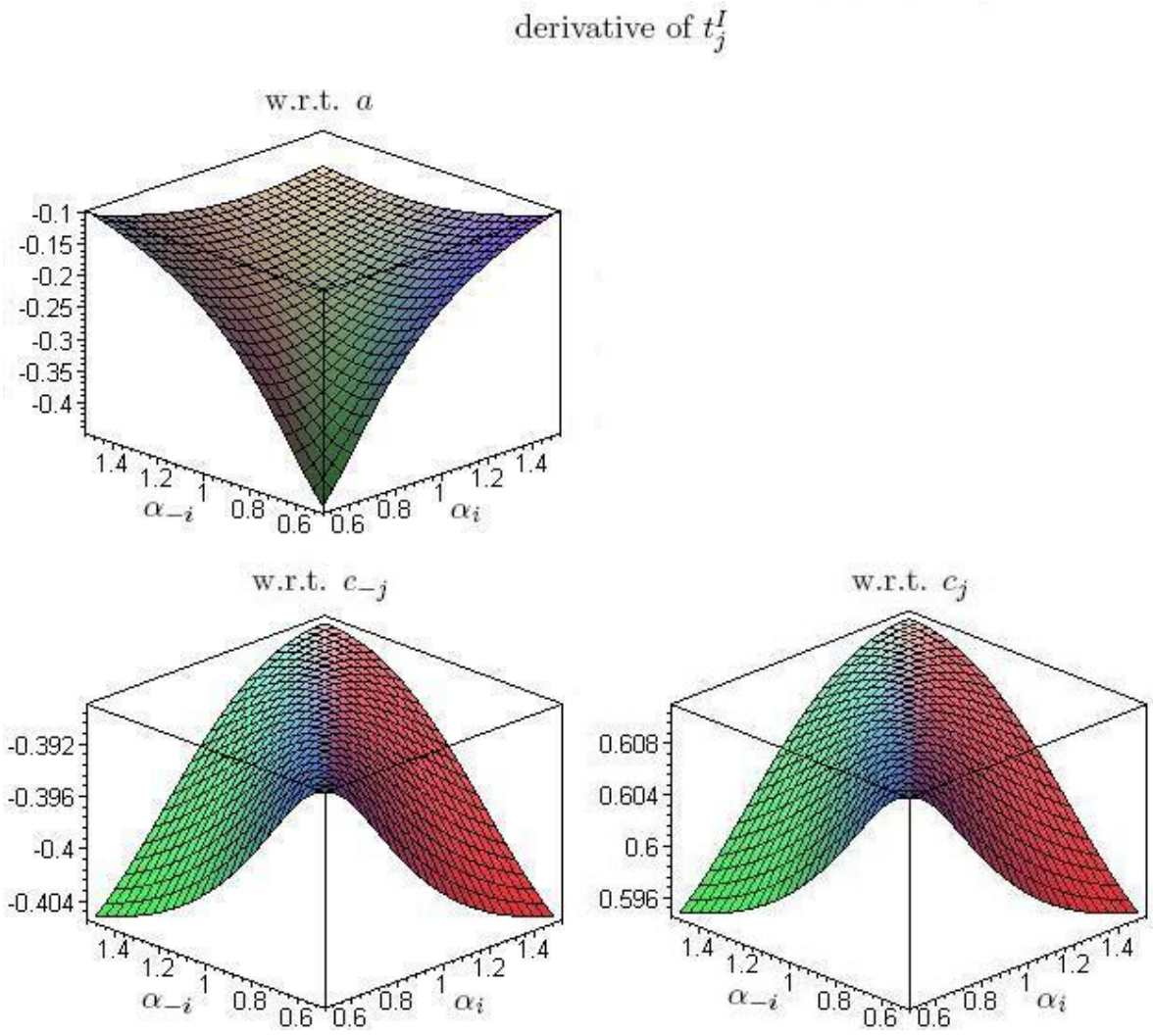


Figure 2.1: The derivatives of t_j^I with respect to a and the c_j s in the four-country case.

The taxes on final-good production are given by

$$t_i^F = - \frac{(\alpha_1 + \alpha_2)(2\alpha_{-i} - \alpha_i)((104\alpha_{-i}^4 - 208\alpha_i\alpha_{-i}^3 + 273\alpha_1^2\alpha_2^2 - 169\alpha_i^3\alpha_{-i} \\ (1160(\alpha_1^6 + \alpha_2^6) - 3624(\alpha_1^5\alpha_2 + \alpha_1\alpha_2^5) + 7302(\alpha_1^4\alpha_2^2 + \alpha_1^2\alpha_2^4) - 8633\alpha_1^3\alpha_2^3) \\ + 56\alpha_i^4)a - (72\alpha_i^5 - 188\alpha_i^4\alpha_{-i} + 292\alpha_i^3\alpha_{-i}^2 - 252\alpha_i^2\alpha_{-i}^3 + 136\alpha_i\alpha_{-i}^4 \\ - 32\alpha_{-i}^5)(c_1 + c_2))}{(2\alpha_{-i} - \alpha_i)(c_1 + c_2)}. \quad (2.21)$$

As in the intermediate good producing industries, the governments in the final good producing countries also tend to subsidize their production (see figure 2.2). The higher the productivity (the smaller α_i) of country i 's production and the smaller the productivity (the larger α_{-i}) of the country $-i$'s production, the larger is the influence of the market size a of the consumer market on country i 's trade policy. This is a similar result as in Bernhofen (1997)¹⁵, where one foreign intermediate-good supplier serves two final good producing monopolists. If the intermediate-good supplier prices the monopolists uniformly, both government in the final good producing countries subsidize their monopolist's production. But, in my model it can also be that one government in the final good producing countries imposes a tax on its production. This is the case for country i , if country $-i$'s production is more than twice as efficient as country i 's production. The costs c_j of the intermediate good producing countries have only a minor effect on the trade policy in the final good producing countries. They have a slight tendency to reduce a subsidy or increase a tax, but there are also parameter values, for which the costs influence the trade policy in the other direction.

Proposition 2.1: *In the four-country case and with $a \gg c_j$ ($j = 1, 2$), intermediate-good production always gets subsidized: $t_j^I < 0$ ($j = 1, 2$). The subsidy (absolute value) increases with the foreign cost of production c_{-j} and decreases with the domestic cost of production c_j . The policy on final-good production is ambiguous. If foreign production is not more than twice as efficient as domestic production ($2\alpha_{-i} > \alpha_i$)¹⁶, there tends to be a subsidy on domestic production ($t_i^F < 0$). If foreign production is more than twice as efficient as domestic production ($2\alpha_{-i} < \alpha_i$), there tends to be a tax on domestic production ($t_i^F > 0$).*

As I have already mentioned above, the results in our benchmark case with a

¹⁵In Bernhofen's model the final-good producers are equally efficient ($\alpha_1 = \alpha_2 = 1$).

¹⁶This is the condition for $\partial t_j^I / \partial a$ to be equal to zero. Even with $a \gg c_j$, the exact point at which the policy switches from a subsidy to a tax depends obviously on the c_j s.

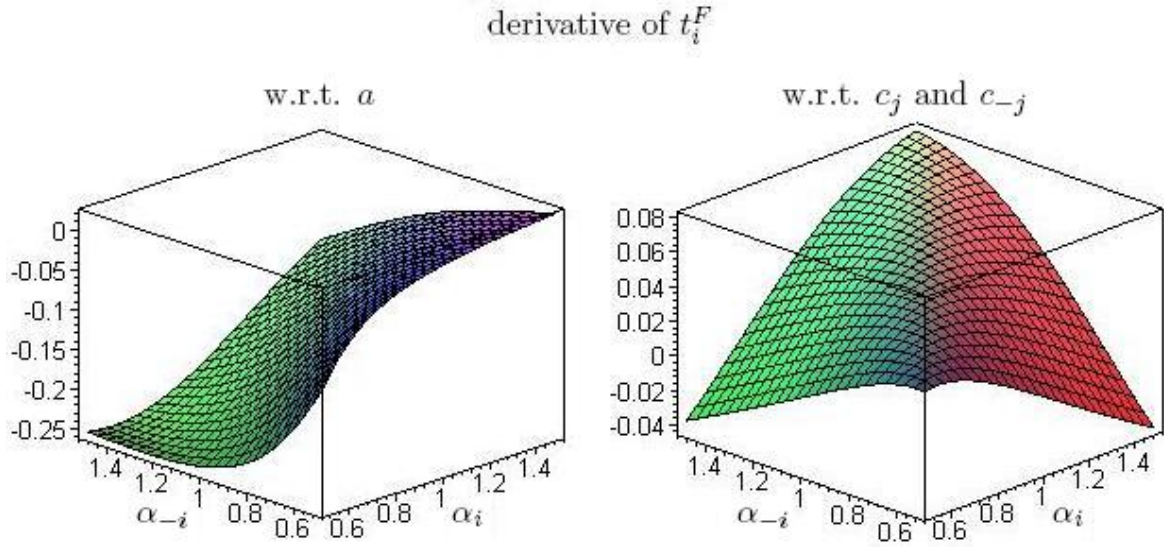


Figure 2.2: The derivatives of t_i^F with respect to a and the c_j s in the four-country case.

symmetric industry distribution confirm the results of the related literature. As a new result we have shown, that if one final-good producer is far less efficient than its competitor, the optimal policy on its production can be a subsidy instead of a tax. In the next section, we analyze the case of an asymmetric industry distribution over three countries. There the strategic trade policy will dramatically change in comparison to the policy with a symmetric industry distribution.

2.3.2 Trade Policy with an Asymmetric Industry Distribution

We proceed with the case in which the industries are asymmetrically distributed over three countries. There is one country where both an intermediate-good producer and a final-good producer are located and there are two countries in which only one industry (in one country a final, in the other an intermediate good producing monopolist) is located. The asymmetric distribution of the industries will obviously influence the strategic trade policy of all three countries. It is likely that the country with both industries has a strategic advantage over the other countries. It can more aggressively shift profits horizontally since part of the profits that are shifted vertically by such a policy adds to its own welfare. The interesting question is how strong the advantage is and how much it depends on the (relative) efficiency of the intermediate- and final-good production in the three countries.

The non-specialized country (NSC) maximizes the profits of its two industries and

the tax revenues collected:

$$W_1 = \pi_1^I + t_1^I x_1 + \pi_1^F + t_1^F y_1. \quad (2.22)$$

The specialized countries (SCs) maximize the following welfare functions:

$$W_2^I = \pi_2^I + t_2^I x_2, \quad (2.23)$$

and

$$W_2^F = \pi_2^F + t_2^F y_2. \quad (2.24)$$

Best response functions. As in the section before, we will first discuss the best response functions. While the best response functions of the SCs are still the same as in the four-country case, the best response functions of the NSC are different. The NSC's best response function for the intermediate-good sector is given by

$$\begin{aligned} t_1^I = & - \frac{(11\alpha_1^3 - 18\alpha_1^2\alpha_2 + 21\alpha_1\alpha_2^2 - 4\alpha_2^3)a - (2\alpha_1 - \alpha_2)(2\alpha_1^2 + 5\alpha_2^2 - 2\alpha_1\alpha_2)t_1^F}{2(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)(8\alpha_1^2 + 11\alpha_2^2 - 8\alpha_1\alpha_2)} \\ & + \frac{(11\alpha_1^3 - 15\alpha_1^2\alpha_2 + 18\alpha_1\alpha_2^2 - 10\alpha_2^3)t_2^F + 2(2\alpha_2 - \alpha_1)(\alpha_1^2 + \alpha_2^2)(t_2^I + c_2)}{2(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)(10\alpha_1^2 + 7\alpha_2^2 - 10\alpha_1\alpha_2)c_1}. \end{aligned} \quad (2.25)$$

The NSC subsidizes its intermediate-good production as the derivative of t_1^I with respect to a is always negative.¹⁷ If the NSC subsidizes also its final-good production ($t_1^F < 0$), this tends to increase the subsidy in the intermediate-good sector.¹⁸ This is similar to the four-country case, in which subsidies on final-good production increase the demand for intermediate goods and thereby the incentive to subsidize them. This effect does not dominate the influence of the final good producing SC's policy t_2^F on the NSC's policy. It is ambiguous whether t_2^F decreases or increases the NSC's subsidy on intermediate-good production. In many cases ($\alpha_1 > 0.77\alpha_2$) a tax on foreign final-good production increases the NSC's incentives to subsidize as such a tax increases the

¹⁷For $(\alpha_1, \alpha_2) \in [0.5, 1.5]^2$.

¹⁸As long as $2\alpha_1 > \alpha_2$.

market share of the domestic final-good producer. Hence, more of the profits shifted vertically by a subsidy add to the NSC's welfare. The tax t_2^I on and cost c_2 of foreign intermediate-good production tend to increase the NSC's subsidy on intermediate-good production. The effects of the policy on the final-good sector also play a role as the influence of t_2^I and c_2 increases with the foreign efficiency parameter α_2 of final-good production and decreases with the domestic efficiency parameter α_1 .¹⁹ If domestic final-good production is very inefficient ($\alpha_1 > 2\alpha_2$), it can be that t_1^I decreases with t_2^I and c_2 . As usual, the domestic cost c_1 reduces the subsidy t_1^I on the domestic production.

The best response function for the final-good sector is given by

$$t_1^F = - \frac{(8(\alpha_1^4 + \alpha_2^4) + 5(\alpha_1^3\alpha_2 + \alpha_1\alpha_2^3) - 6\alpha_1^2\alpha_2^2)a + (2\alpha_2 - \alpha_1)^2(8\alpha_1^2 + 5\alpha_2^2 - 5\alpha_1\alpha_2)}{(56\alpha_1^4 - 112\alpha_1^3\alpha_2 + 192\alpha_1^2\alpha_2^2 - 136\alpha_1\alpha_2^3 + 71\alpha_2^4)} \\ \frac{t_2^F + 2(2\alpha_1 - \alpha_2)(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)((7\alpha_1^2 + 4\alpha_2^2 - 7\alpha_1\alpha_2)(t_2^I + c_2)}{- (2\alpha_1^2 + 5\alpha_2^2 - 2\alpha_1\alpha_2)t_1^I - (11\alpha_1^2 + 14\alpha_2^2 - 11\alpha_1\alpha_2)c_1}.$$

In contrast to the four-country case and the SC, the NSC unambiguously subsidizes its final-good production. The derivative of t_1^F with respect to a is strictly negative and symmetrically dependent on α_1 and α_2 . For the basic direction of its trade policy it does not play a role whether the NSC's final-good production is relatively less or more productive than its foreign competitor's. As we will see in the following, the relative efficiency of its production anyhow plays an important role for the NSC's policy on final-good production. The NSC's subsidy t_1^F on final goods increases with the competing countries tax t_2^F on final goods. For all other variables, their effect on the NSC's policy is ambiguous. In most cases ($2\alpha_1 > \alpha_2$) domestic costs c_1 and taxes t_1^I in the intermediate-good sector reduce the NSC's subsidy on final goods, while the foreign costs c_2 and taxes t_2^I increase the subsidy t_1^F . As in the four-country case, this correlation is reversed, if domestic production is far more efficient than foreign final-good production ($2\alpha_1 < \alpha_2$). Having studied the best response functions of the NSC, we now analyze the structure of the equilibrium taxes.

Equilibrium taxes. First, we have a look at the equilibrium subsidy the NSC

¹⁹If $\alpha_1 < 2\alpha_2$.

grants on its intermediate-good production:

$$t_1^I = -\frac{3(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)(14\alpha_1^3 - 27\alpha_1^2\alpha_2 + 39\alpha_1\alpha_2^2 - 10\alpha_2^3)a + 4\alpha_2}{4(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)^2(16\alpha_1^2 + 28\alpha_2^2 - 19\alpha_1\alpha_2)} \\ \frac{(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)(2\alpha_1^3 + 8\alpha_1^2\alpha_2 - 11\alpha_1\alpha_2^2 + 10\alpha_2^3)c_2 - (108\alpha_1^6 - 328\alpha_1^5\alpha_2}{+663\alpha_1^4\alpha_2^2 - 782\alpha_1^3\alpha_2^3 + 641\alpha_1^2\alpha_2^4 - 306\alpha_1\alpha_2^5 + 88\alpha_2^6)c_1}. \quad (2.26)$$

As one can easily see, the NSC's trade policy in the intermediate-good sector depends crucially on the efficiency of its final-good production in comparison to the foreign final-good production. If one analyzes the derivative of t_1^I with respect to the market size a , one can see a clear trend (see figure 2.3):²⁰ The subsidization is overall more aggressive than in the four-country case. Surprisingly, it is even more aggressive, when the domestic final-good producer is less efficient than its foreign competitor ($\alpha_1 > \alpha_2$). The reason are the reduced costs of subsidization for the NSC. The very aggressive trade policy on the one hand reduces the intermediate-good prices and thereby the profits of the intermediate-good monopolists, but on the other hand increases the profits of the final-good monopolists. This effect tends to be larger the more inputs the NSC's final-good producer needs and thus it is larger where the NSC's monopolist is less efficient than its foreign competitor.

But, it is worthwhile to notice that there are also parameter values ($2\alpha_1 < \alpha_2$) for whom the NSC's policy is less aggressive than the policy in the four-country case.²¹ The reason has already been given above. If the efficiency advantage of the domestic final-good producer is very large, he does not benefit from small input prices anymore, because they help his competitor more than himself. For ($2\alpha_1 < \alpha_2$), as we will see in the next paragraph, the costs of intermediate-good production are more important for the direction of trade policy (as $\partial t_1^I / \partial a$ is close to zero).

We now analyze how the influence of the marginal costs of intermediate-good production on trade policy has changed in comparison to the four-country case (see figure 2.4). If the foreign final-good production is less efficient than the production in the NSC ($\alpha_2 > \alpha_1$), the subsidy in the NSC increases with the foreign cost and decreases with the domestic cost of intermediate-good production. The derivatives expressing

²⁰Unfortunately a fifth order polynom does not yield unambiguous results, but in the graphs the trends can be clearly identified.

²¹If one solely analyzes $\partial t_1^I / \partial a$.

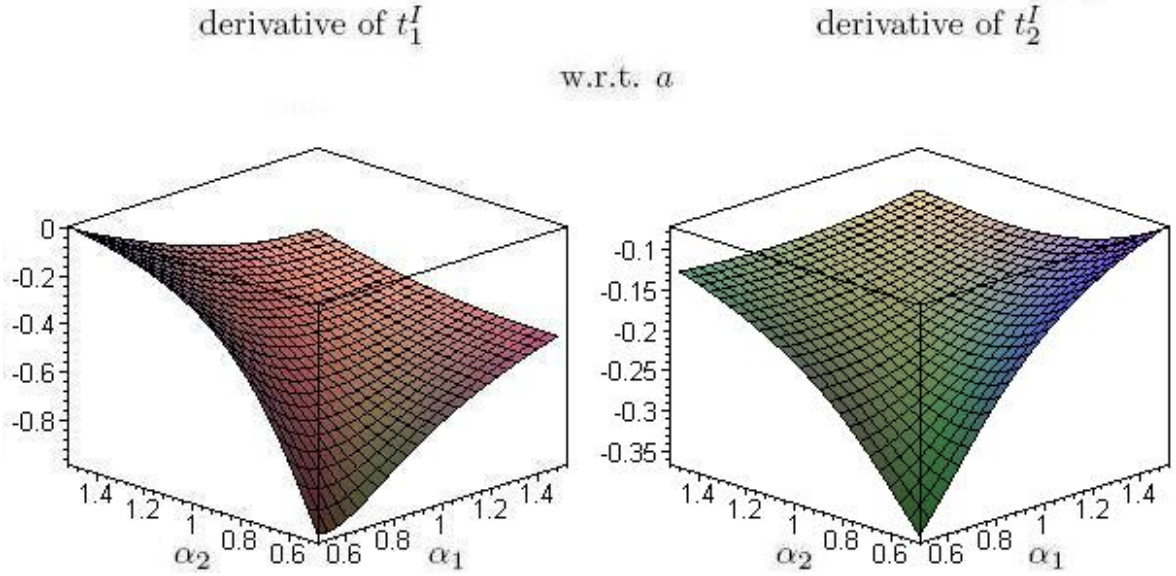


Figure 2.3: The derivatives of t_1^I and t_2^I with respect to a in the three-country case.

the costs' influence on the subsidy have a similar size as in the four-country case. For $\alpha_2 > 2\alpha_1$, the NSC taxes its intermediate-good production, if the domestic cost of intermediate-good production is sufficiently large in comparison to the foreign cost.²²

If the foreign final-good production is more efficient than the production in the NSC ($\alpha_1 > \alpha_2$), we observe that on the one hand the foreign cost c_2 of intermediate-good production has a smaller influence on the subsidy. On the other hand, the subsidy reducing influence of the NSC's cost c_1 of intermediate-good production becomes very large. As mentioned above, the NSC subsidizes the intermediate-good sector for $\alpha_1 \gg \alpha_2$ very aggressively. But, if in that case the domestic costs of intermediate-good production are additionally very high, the subsidization does not pay off as most of the profits shifted vertically benefit the foreign intermediate-good producer. Hence, the domestic costs have a strong diminishing effect on the subsidy.

Proposition 2.2: *In the three-country case and with $a \gg c_j$ ($j = 1, 2$), the NSC tends to subsidize its intermediate-good production. If domestic final-good production is far more efficient than foreign final-good production ($\alpha_2 \gg 2\alpha_1$) and if $c_1 \gg c_2$, the policy can switch to a tax. t_1^I always decreases with the foreign cost of intermediate-good production c_2 and always increases with the domestic cost of intermediate-good production c_1 .*

²²As mentioned above the $\partial t_1^I / \partial a$ is then close to zero.

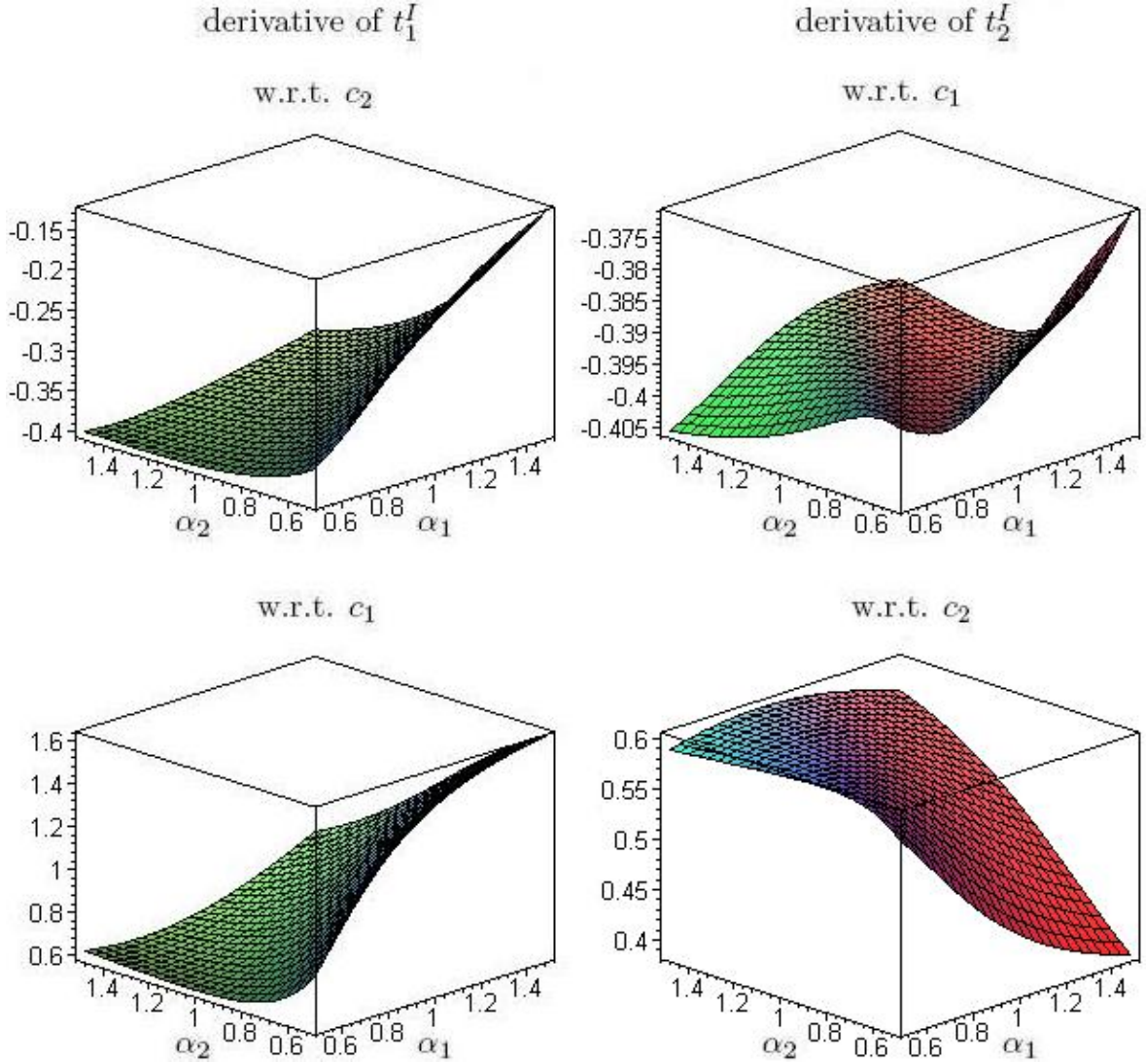


Figure 2.4: The derivatives of t_1^I and t_2^I with respect to the c_j s in the three-country case.

We proceed by analyzing the non-specialized country's policy in the final-good sector. The equilibrium subsidy on final-good production is given by

$$\begin{aligned}
 t_1^F = & -\frac{(7\alpha_1^2 + 10\alpha_2^2 - \alpha_1\alpha_2)}{2(16\alpha_1^2 + 28\alpha_2^2 - 19\alpha_1\alpha_2)}a - \frac{2(2\alpha_1 - \alpha_2)(8\alpha_1^2 + 10\alpha_2^2 - 9\alpha_1\alpha_2)}{3(16\alpha_1^2 + 28\alpha_2^2 - 19\alpha_1\alpha_2)}c_2 \\
 & + \frac{(2\alpha_1 - \alpha_2)(59\alpha_1^4 - 128\alpha_1^3\alpha_2 + 219\alpha_1^2\alpha_2^2 - 154\alpha_1\alpha_2^3 + 88\alpha_2^4)}{6(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)(16\alpha_1^2 + 28\alpha_2^2 - 19\alpha_1\alpha_2)}c_1. \quad (2.27)
 \end{aligned}$$

The strategic trade policy in the NSC's final-good sector deviates systematically

from the policy in the four-country case. The first observation is that the NSC on average subsidizes more (dependent on a) than the final good producing countries in the four-country case (see figure 2.5). In the four-country case the subsidies on the final-good production increase with the relative efficiency of the production in comparison to the foreign competitor. The opposite is true for the NSC's policy in the three-country case. There, the subsidization dependent on the market size a is more aggressive, if the domestic final-good production is less efficient than the foreign one ($\alpha_1 > \alpha_2$). The reason is that the demand for intermediate goods increases strongly with subsidies on inefficiently produced final goods. Therefore, vertical rent shifting is in that case more efficient. Interestingly, the derivative of t_1^F with respect to a has a similar size as in the four-country case in which domestic production is relatively most efficient. This supports the argument that the stronger subsidization discussed above aims at vertical rent shifting. Obviously, the NSC should shift profits vertically only if the domestic monopolist earns a large share of the profits in the intermediate-good market. This is ensured by the NSC's policy towards final-good production depending on the cost of intermediate-good production.

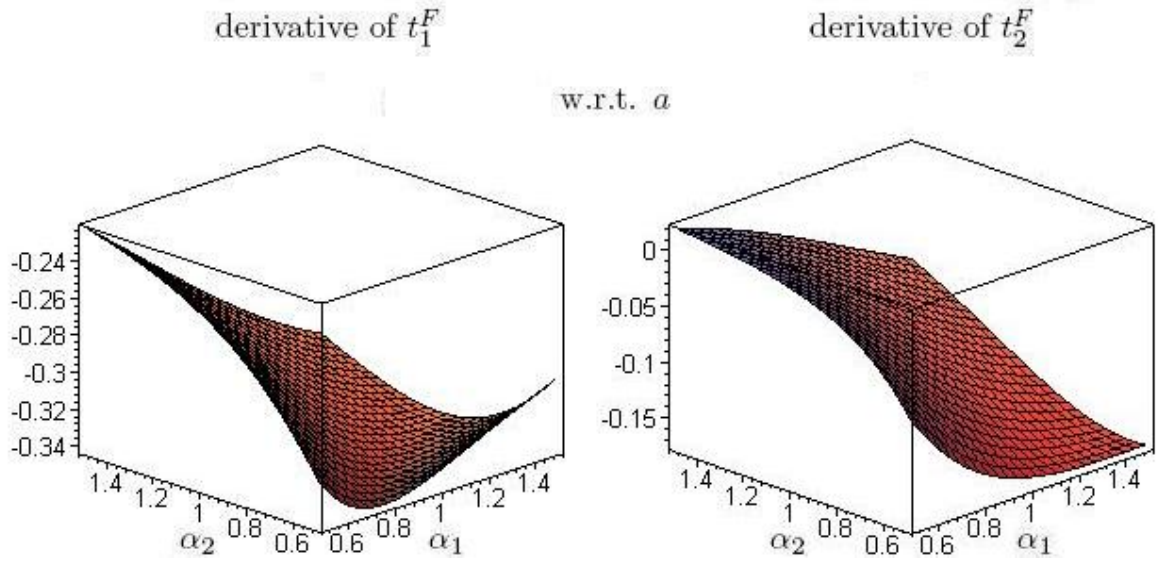


Figure 2.5: The derivatives of t_1^F and t_2^F with respect to a in the three-country case.

In the four-country case the trade policy in the final good producing countries hardly depends on the costs c_j of intermediate-good production. This is completely different in the three-country case, in which they play an important role (see figure 2.6). As mentioned above they are used to control the vertical rent shifting. Increasing foreign costs of intermediate-good production tend to increase the subsidy

on final-good production and increasing domestic costs tend to reduce the subsidy. The derivatives of t_1^F with respect to both costs increase (in absolute values) with the relative efficiency of the foreign intermediate-good production. Thereby, the influence of the costs is strongest for values of α_1 and α_2 for which also the vertical rent shifting with respect to a is most intensive.

Proposition 2.3: *In the three-country case and with $a \gg c_j$ ($j = 1, 2$), the NSC always subsidizes its final-good production. The influences of the costs c_j of intermediate-good production on the subsidy t_1^F are ambiguous. If $2\alpha_1 \geq \alpha_2$, t_1^F decreases (increases) with the foreign (domestic) cost of intermediate-good production c_2 (c_1), otherwise it increases (decreases) with c_2 (c_1).*

Altogether, we have seen how the NSC tailors its trade policy in both domestic sectors to optimally shift profits both vertically and horizontally. We now analyze whether and how the NSC's policy influences the policy of the two countries where only an intermediate- or a final-good monopolist is located. We start with the trade policy of the intermediate good producing SC:

$$t_2^I = -\frac{27\alpha_2}{6(16\alpha_1^2 + 28\alpha_2^2 - 19\alpha_1\alpha_2)}a + \frac{(16\alpha_1^2 + 46\alpha_2^2 - 19\alpha_1\alpha_2)}{3(16\alpha_1^2 + 28\alpha_2^2 - 19\alpha_1\alpha_2)}c_2 - \frac{(68\alpha_2^4 - 109\alpha_1\alpha_2^3 + 132\alpha_1^2\alpha_2^2 - 64\alpha_1^3\alpha_2 + 32\alpha_1^4)}{6(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)(16\alpha_1^2 + 28\alpha_2^2 - 19\alpha_1\alpha_2)}c_1 \quad (2.28)$$

As the best response functions of the SCs' are the same as in the four-country case, all changes in the SCs' tax structure in comparison to the taxes in the four-country case are caused by the NSC's trade policy. By analyzing the derivative of t_2^I with respect to the market size a , one can already see that the NSC's policy influences the intermediate good producing SC's policy (see again figure 2.3). First of all, as a reaction to the NSC's aggressive policy, the SC's subsidization is less intensive than in the four-country case. The derivative is additionally slightly influenced by the efficiency parameters (α_i) of final-good production. The only explanation for this asymmetry is the (asymmetric) trade policy of the NSC on its intermediate (and final) good production. The SC's subsidization (depending on a) is stronger when the NSC's policy is less aggressive ($\alpha_1 < \alpha_2$) and weaker when the NSC's policy is more aggressive ($\alpha_1 > \alpha_2$).

The derivatives of t_2^I with respect to the costs c_i of intermediate-good production

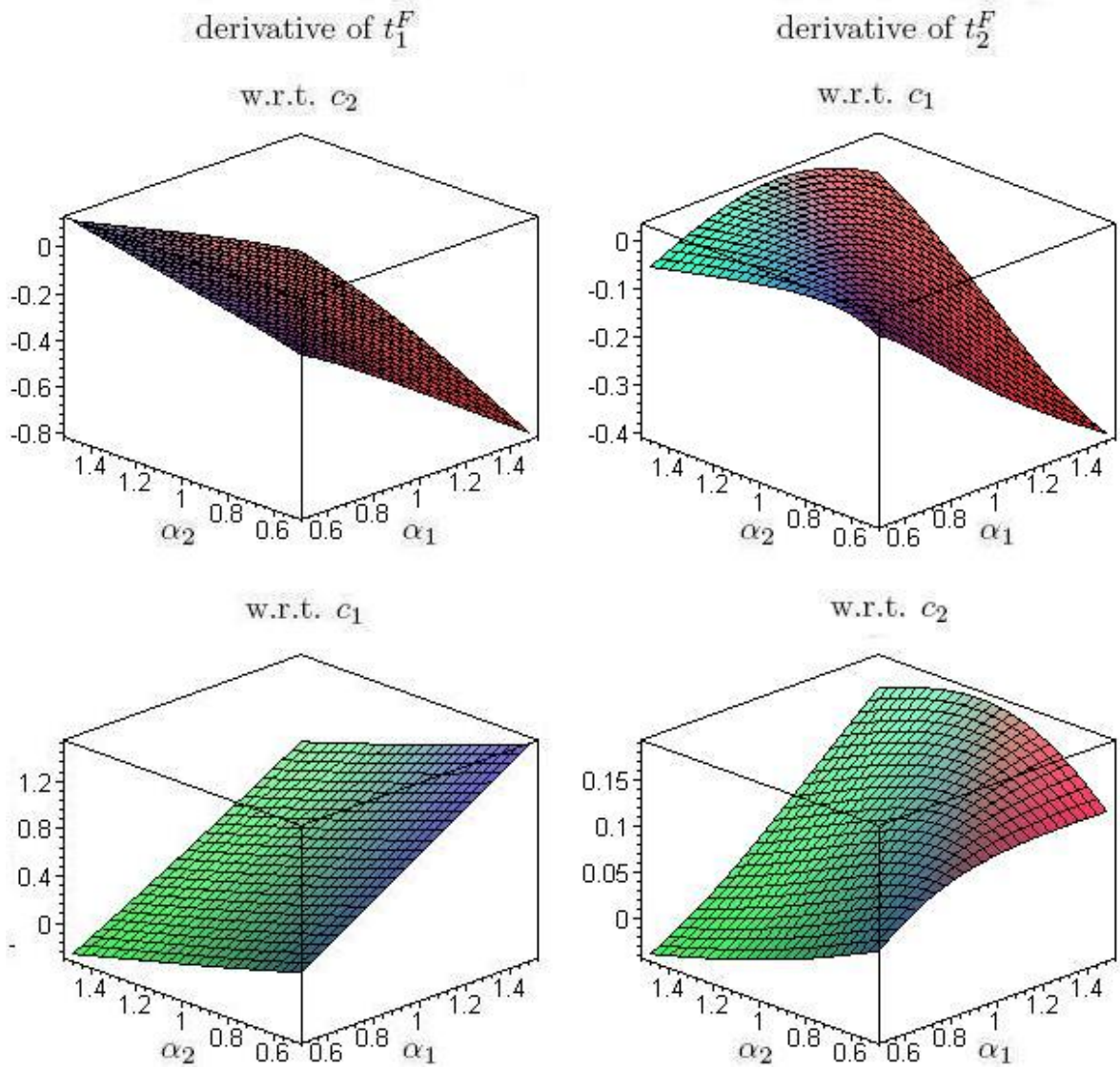


Figure 2.6: The derivatives of t_1^F and t_2^F with respect to the c_j s in the three-country case.

are as well affected by the efficiency parameters (α_i) of final-good production (see again figure 2.4). While they have a similar shape as in the four-country case for $\alpha_2 > \alpha_1$, where also the NSC's policy is similar to the four-country case, they are very different for $\alpha_1 > \alpha_2$, where the NSC's policy deviates systematically from the four-country case.

Proposition 2.4: *In the three-country case and with $a \gg c_j$ ($j = 1, 2$), the SC always subsidizes its intermediate-good production. t_2^I always decreases with the foreign cost of intermediate-good production c_1 and always increases with domestic cost of intermediate-good production c_2 .*

That the policy in the country specialized in final-good production is also influenced by the NSC's policy should already be clear. What this influence looks like can be seen in the corresponding tax function:

$$t_2^F = -\left(\frac{(\alpha_1 + \alpha_2)(2\alpha_1 - \alpha_2)}{16\alpha_1^2 + 28\alpha_2^2 - 19\alpha_1\alpha_2}\right) \cdot \left(a + \frac{(6\alpha_1^3 - 11\alpha_1^2\alpha_2 + 14\alpha_1\alpha_2^2 - 8\alpha_2^3)}{3(\alpha_1^2 + \alpha_2^2 - \alpha_1\alpha_2)}c_1 - \frac{4}{3}\alpha_2c_2\right) \quad (2.29)$$

The policy depending on the market size a is hardly affected by the asymmetric industry distribution over countries (see again figure 2.5). The derivative with respect to a has a similar shape (with a bit smaller values) as in the four-country case, which means that the subsidy (a tax for some parameter values) increases, the more efficient the own and the less efficient the foreign final-good production is. The influence of the NSC can be clearly seen in the effect that the costs of intermediate-good production have on the SC's trade policy (see again figure 2.6). While these costs have hardly any influence on the trade policy of the final good producing countries in the four-country case, they are here, as a reaction to the NSC's policy, dependent on these costs. The costs have the opposite influence on the taxes as they have on the taxes of the NSC. For parameter values of the α_i 's, where the costs of intermediate-good production tend to increase the subsidies in the NSC, they tend to decrease the subsidies in the SC and the other way round.

Proposition 2.5: *In the three-country case and with $a \gg c_j$ ($j = 1, 2$), final-good production does not always get subsidized by the SC. If foreign production is*

not more than twice as efficient as domestic production ($2\alpha_1 > \alpha_2$)²³, there tends to be a subsidy on domestic production. Otherwise, there tends to be a tax on domestic production. The influences of the costs c_j of intermediate-good production on t_2^F are ambiguous. If $2\alpha_1 \leq \alpha_2$ or $1.1\alpha_1 > \alpha_2$, t_2^F decreases with the NSC's cost of intermediate-good production c_1 , otherwise it increases with c_1 . If $2\alpha_1 \leq \alpha_2$, t_2^F decreases with the other SC's cost of intermediate-good production c_2 , otherwise it increases with c_2 .

We have seen in this section that the governments of the SCs act in pursuance with the NSC's policy. Unfortunately, an analysis of the welfare effects is not feasible in my framework. But it seems plausible to state that the more aggressive trade policy of the NSC is a sign for a strategic advantage over the SCs. This strategic advantage clearly leads to larger market shares for the NSC in comparison to the four-country case (for the same parameter values). Hence, it is reasonable to conclude that the specialization in one kind of industry leads to a reduced welfare, at least from the perspective of strategic trade policy. It is absolutely clear that this is only one aspect and it would be invalid to conclude that the specialization on one industry is hurtful. But its influence on strategic trade policy should not be neglected and taken into consideration in the development of industrial policy.

2.4 Conclusion

This chapter examined the implications of internationally integrated intermediate-good and final-good markets for strategic trade policy if there is Cournot imperfect competition in both markets and both goods are assumed to be substitutes. Special attention is given to the interactions between the policy towards intermediate- and final-good production in a non-specialized country where both kinds of goods are produced. We show that there are strong interactions. If increased intermediate-good prices hurt the foreign more than the domestic final-good producer, it can be that the non-specialized country taxes its intermediate-good production. On the other hand, the maximization of the intermediate-good producer's profits influences the NSC's policy towards the final-good sector. If intermediate-good profits were not included, the subsidization of final-good production would increase with the relative efficiency of domestic

²³This is the condition for $\partial t_2^F / \partial a$ to be equal to zero. Even with $a \gg c_j$, the exact point at which the policy switches from a subsidy to a tax depends obviously on the c_j s.

in comparison to foreign final-good production. The opposite can be true if domestic intermediate-good profits are taken into account, because more profits can be shifted vertically in case of an inefficient final-good production. Therefore, the subsidization of final-good production can decrease with the relative efficiency of production, if the domestic intermediate-good producer captures a large share of the profits shifted vertically. Additionally, it is analyzed whether a non-specialized country has a strategic advantage over countries in which only intermediate or final goods are produced. We can show that a country with both kinds of industries acts more aggressively in strategic trade policy than vertically specialized countries. Thus, it can be concluded that the non-specialized country's profits plus the tax revenues in both sectors (at least the sum over both sectors) are larger than those in the specialized countries.²⁴ Therefore, at least from the perspective of strategic trade policy, countries take a risk, if they vertically specialize in final- or intermediate-good production. Especially, if the country they internationally compete against is not vertically specialized and has the ability to influence the world market prices by its policy.

Finally, I want to emphasize that, due to the high structural complexity and the asymmetry of my model, I had to make concessions concerning the generality of the functional forms and the market structure. We assumed Cournot competition in both the intermediate-good and the final-good market. Each industry consists out of one monopolist with linear cost functions. By analyzing monopolists we rule out the terms of trade effect. This effect arises when there is more than one firm. Since the firms do not take into account the effect of their exports on the exports of other firms, their overall production goes beyond the joint profit maximizing level. Then the government has an incentive to reduce the overall production by imposing a tax (see Eaton and Grossman 1986 and Krishna and Thursby 1991). As these effects were not in the focus of my research, we used a simpler framework with monopolies. Even though my framework may exclude some interesting cases, it provides new insights into the functioning of strategic trade policy.

²⁴Of course only for the same parameter values.

Chapter 3

Education Choice with Social Preferences

3.1 Introduction

Both, family background and social environment have strong effects on a child's educational attainment. Empirics show that having parents with positive characteristics like high income, good educational level or high occupational status improves a child's probability of educational and occupational success (see, e.g., Solon 1992, Mulligan 1997, Robertson and Symons 2003, and Fuchs and Wößmann 2006). To find explanations for the importance of family background for educational attainment theory mainly concentrates on the better exogenous opportunities a child with wealthy or well educated parents faces. Typical explanations are the family transmission of ability, imperfect capital markets, local segregation or self-fulfilling beliefs.¹ In contrast, I think that not only the better opportunities but also the higher incentives to learn are responsible for the better educational performance of richer children. Before discussing where this higher incentives stem from, we introduce the second main issue of this chapter. Similar as in the case of a good family background, empirics also show that a good social environment has a positive influence on a child's educational success. Having friends or classmates (a peer group²) with a good family background, good grades in school or ambitions for a high social status seems to increase a child's educational attainment (see, e.g., Simpson 1962, Hoxby 2000, Sacerdote 2001, Hanushek et

¹A broader summary of these theories can be found in section 3.4.

²'Peer group' is a common expression in education theory, but it is not narrowly defined. In many papers the peers are just all other students in class, in other papers only some students in class and in further papers also friends are included that need not to be in same class as the analyzed individual.

al. 2003, and Robertson and Symons 2003). As they are empirically well established, economists often append peer group effects to their models, but rarely examine their nature. I think that it is important to detect the channel through which a peer group influences a child's educational success. Do peers automatically transfer ability to a child (spillover effects) or do they somehow shape its education choice? In my opinion the latter is the case and that similarly to the family background also peers influence a child's incentives to get educated.

Why do I think that both family background and social environment influence an individuals' incentives to learn? From my point of view an individual's education choice is not only about maximizing lifetime income. Individuals do additionally care about their relative wealth (income) in comparison to others. Economists try to formalize the idea that individuals are also concerned about the income other people receive in models of social preferences.³ Recent experimental studies underline the importance of social preferences in individuals' economic decisions.⁴ As the (time) investment in education is one of the most important economic decisions for an individual's lifetime income, it is worthwhile to analyze how social preferences change it. If individuals compare themselves with others, one gets a natural link between their education choice, their family background and their social environment (peers).

To consider the comparison with others in education choice is not totally new to the literature and has already been formulated by Merton (1953) and Boudon (1974). Their reference group theory states that individuals compare their social achievements to the reference group from which they come from. They assume that individuals care for maintaining their social status and thereby get the result that upper class children are more motivated to make human capital investments than lower class children. But, the result is more or less driven by assumption. A microfoundation for why individuals suffer from losing social status is missing. I think that my more general way of modeling can explain the persistent inequality across generations without the use of education-specific assumptions.

Another theoretic approach related to my model is developed by Akerlof and Kranton (2002). They assume that students sort into groups at school ('nerds', 'leading crowd' and 'burnouts'). Every group has its own ideal behavior that the students try to fulfill. Since similar students tend to sort in the same group and then have a

³See, e.g., Bolton (1991), Rabin (1993), Fehr and Schmidt (1999), Bolton and Ockenfels (2000), and Andreoni and Miller (2002).

⁴See Fehr and Schmidt (1999), Fehr and Gaechter (2000), Henrich et al. (2001), and Charness and Rabin (2002).

bias towards the group's ideal, the group members have correlations in their education choice. Their and my approach are similar, since in Akerlof and Kranton's model the individuals suffer from being different than their group's ideal, while in my approach the individuals suffer from being different than their peers. But, from my point of view, in Akerlof and Kranton's model an explanation is missing why students sort into groups and where their ideals come from.

The theory reflecting social preferences I use in my model is the concept of inequity aversion introduced by Fehr and Schmidt (1999).⁵ They state that individuals do not only care about their material self interest, but also about their relative income in comparison to a reference group. Individuals' utility gets reduced both from being better off and from being worse off than the reference group. With a utility function that captures this idea, Fehr and Schmidt can explain experimental evidence that is inconsistent with the assumption of purely self-interested individuals. As argued above, I think that inequity aversion plays an important role in education choice and hence integrate Fehr and Schmidt's utility function into an education choice model. In my model an individual lives two periods. The first period is called adolescence and the second period working life. In both periods the individual's utility depends on its income and its relative income. We assume that an individual compares its income to a peer group which consists of friends, classmates and relatives.⁶ In adolescence the individual receives its education, in working life its income is depending on the time invested in education in adolescence and on its ability. Income in the first period is partly financed by parents and partly by earnings that can be realized by investing time in a job in adolescence.

With my framework, we get the following results: The education choice of inequity averse individuals deviates systematically from the education choice of purely self-interested individuals. Inequity averse students who are in adolescence relatively poor in comparison to their peer group invest less time in education than students who are relatively rich in comparison to their peers. The reason for relatively poor students to choose less education is their higher opportunity costs of education. If they work in adolescence, they can reduce the income gap in comparison to their peers and thereby reduce their losses induced by inequity aversion. For inequity averse individuals it is

⁵My model would yield qualitatively the same results, if I used the alternative formalization of inequity aversion introduced by Bolton and Ockenfels (2000). I use Fehr and Schmidt's utility function because it generates clearer results in my framework.

⁶In experiments the reference group, an agent compares himself with, are just the other players involved in the game. In real life situations it is not totally clear which persons an individual uses as reference points.

additionally no longer true that investment in education strictly increases with ability. For almost all exogenous parameter values of my model there are intervals of ability in which investment in education decreases with ability. If parental income is symmetrically and uniformly distributed around the peer group's income, time investment in education (averaged over ability) increases with the peer group's income. The reason is that having a rich peer group in working life gives additional incentives to choose a high level of education, while having a poor peer group in working life reduces the incentives to choose a high level of education.

The chapter is organized as follows. Section 3.2 describes the model and the outcome of an individual's education choice is calculated. We analyze how the education choice of inequity averse individuals differs from the education choice of purely self-interested individuals in section 3.3. In section 3.4 we discuss the role family background plays in my model and compare the results to the related literature. Then, we do the same for peer groups in section 3.5. In section 3.6 we discuss my model's implications for education policy, before section 3.7 finally concludes. The appendix contains the proofs of my propositions and some figures that illustrate an individual's education choice.

3.2 The Model

The model analyzes how individuals choose their education level. Each individual lives for two periods, adolescence a and working life w . The income per period is x_i with $i = a, w$.⁷ An adolescent visits schools and other educational institutions. His educational success (i.e. human capital at the end of education) depends on his initial ability (or talent) θ at the moment of school enrollment⁸ and his time investment in education e . Ability θ is drawn from some distribution F with support $(0, \bar{\theta}]$.⁹ Besides in education an adolescent can invest his time endowment \bar{H} in work h and in leisure l . The return to work in adolescence is assumed to be independent of ability and equal to the time invested. I think this assumption is realistic since most of the jobs

⁷All variables and parameters in my model could have an index j to symbolize that they are individual. We completely suppress such an index, but we always talk about individually varying variables and parameters in my model.

⁸Initial ability in our sense is surely already influenced by parental education and social environment. Nevertheless, we neglect all pre-school influences as they would not change the education choice described in my model.

⁹The upper ability limit $\bar{\theta}$ is introduced for technical reasons. It can be arbitrary large as long as it is finite. It will later on be specified more precisely.

one does parallel to education do not reward special intellectual abilities or hitherto existing educational success. In adolescence income x_a is the sum of a share of parental income γp and own income h . That a child's income increases with its parents' income seems plausible as both direct transfers (pocket money) and common consumption (habitation, food, car, etc.) should typically be positively correlated with parents' income. In working life income is the wage times the ability θ times the time invested in education e (plus 1). For simplicity, we normalize the wage, time endowment \bar{H} and the share of parents' income γ to 1. We assume capital market imperfections, i.e. it is not possible to take a credit on future income in adolescence. This assumption should come close to reality as borrowing (before or during education) on future income evokes strong adverse selection and moral hazard problems.

We formalize the utility derived from income by the Fehr/Schmidt utility function. Fehr and Schmidt (1999) state that people are not only motivated by their material self-interest. At least experimental evidence suggests that many people are also concerned with their relative income in comparison to others (Fehr and Schmidt 2003). Many people suffer from being worse off than others (envy) and some people suffer from being better off than others (altruism). Fehr and Schmidt call people inequity averse, if they are envious in the case they are worse off and/or altruistic in the case they are better off than others. For people with inequity aversion the return to an additional unit of income is larger if they are worse off and smaller if they are better off than others in comparison to purely self-interested people. I think that people are not only inequity averse in the laboratory, but also in real life situations. If that is the case, inequity aversion will also influence an individual's education choice. With its education choice a child does not only determine its future income, but also its future losses induced by inequity aversion. We assume that an individual compares itself with a peer group. A peer group in real life consists of relatives, colleagues (class mates) and friends. A strong assumption in my model is that the peer group does not change over time. This is a benchmark case and surely not realistic for most people. But, in my opinion it is convenient for two reasons. Firstly, at least a part of most people's peer group should be constant over time (relatives, some friends) and secondly, at the time an adolescent takes its education choice he can probably not foresee how his peer group will change in future. Even for a partly dynamic peer group (e.g. adjusting to the individual's income) the results of the model would qualitatively carry through. For simplicity, we assume that there is only one person in an individual's peer group (the representative peer) with income y . Thereby, the utility functions for adolescence and working life

are given by

$$U_a = l + h + p - \alpha \max[y - (p + h), 0] - \beta \max[(p + h) - y, 0], \quad (3.1)$$

$$U_w = \theta(1 + e) - \alpha \max[y - \theta(1 + e), 0] - \beta \max[\theta(1 + e) - y, 0], \quad (3.2)$$

with $y, p \geq 0$, $0 \leq \beta \leq 1$ and $\beta \leq \alpha$.¹⁰

We do not discount working life utility in my two-period model, since that would not provide interesting insights for the questions we are dealing with. Hence, lifetime utility sums up to

$$\begin{aligned} U = U_w + U_a = & l + h + p + \theta(1 + e) \\ & - \alpha \max[y - (p + h), 0] - \beta \max[(p + h) - y, 0] \\ & - \alpha \max[y - \theta(1 + e), 0] - \beta \max[\theta(1 + e) - y, 0]. \end{aligned} \quad (3.3)$$

All in all, an individual has to solve the following maximization problem to optimize his education choice:

$$\begin{aligned} \max_{l, h, e} & l + h + p + \theta(1 + e) - \alpha \max[y - (p + h), 0] - \beta \max[(p + h) - y, 0] \\ & - \alpha \max[y - \theta(1 + e), 0] - \beta \max[\theta(1 + e) - y, 0], \end{aligned}$$

w.r.t.

$$\begin{aligned} & l, h, e \geq 0, \\ & l + h + e \leq 1. \end{aligned} \quad (3.4)$$

As the second condition is always binding, we can simplify the problem to

$$\begin{aligned} \max_{h, e} & 1 - e + p + \theta(1 + e) - \alpha \max[y - (p + h), 0] - \beta \max[(p + h) - y, 0] \\ & - \alpha \max[y - \theta(1 + e), 0] - \beta \max[\theta(1 + e) - y, 0], \end{aligned}$$

w.r.t.

$$\begin{aligned} & h, e \geq 0, \\ & h + e \leq 1. \end{aligned} \quad (3.5)$$

¹⁰The assumptions on the values of α and β are taken over from Fehr and Schmidt (1999). They proved to be consistent with the data and imply that people are at least as envious as altruistic. This seems to be a reasonable assumption. $\beta \leq 1$ ensures that utility does not decrease with income.

In the simplified problem a positive derivative with respect to work or education means that the respective variable is more attractive than leisure. We first calculate the parameter values for which this is the case. For parameter values for which both derivatives to work and education are positive, we then have to check whether work or education is more attractive, i.e. which derivative is larger. For $0 \leq h < y - p$ the derivative of U with respect to h is positive:

$$\frac{\partial U}{\partial h} = \alpha. \quad (3.6)$$

For $p > y$ or $h > y - p > 0$ the derivative of U with respect to h is negative:

$$\frac{\partial U}{\partial h} = -\beta. \quad (3.7)$$

This means that as long as an individual is worse off than its peer it prefers work to leisure in adolescence. Otherwise it prefers leisure. To compare the attractiveness of work and leisure with the attractiveness of education we need to calculate the derivative of U with respect to e . For $0 \leq e < \frac{y}{\theta} - 1$ the derivative is

$$\frac{\partial U}{\partial e} = \theta - 1 + \alpha\theta. \quad (3.8)$$

For $y \leq \theta$ or $0 < \frac{y}{\theta} - 1 \leq e$ the derivative is

$$\frac{\partial U}{\partial e} = \theta - 1 - \beta\theta. \quad (3.9)$$

The first part of both derivatives $\theta - 1$ is the return to education minus the opportunity costs of less leisure without inequity aversion. With inequity aversion the individual has an additional incentive to learn ($\alpha\theta$) as long as it is worse off than its peer in working life. As soon as it is better off than its peer the inequity aversion reduces its incentive to learn ($-\beta\theta$).

Now, it is possible to calculate the levels of θ that make education more attractive than leisure and work. As already mentioned leisure is superior to work for $y \leq p$ or $0 < y - p \leq h$. Therefore, in this case education is chosen, if it is superior to leisure. The individual prefers education to leisure if the derivative of U with respect to e is positive. In case $0 \leq e < \frac{y}{\theta} - 1$ this holds for

$$\theta > \frac{1}{1 + \alpha}. \quad (3.10)$$

In case $y \leq \theta$ or $0 < \frac{y}{\theta} - 1 \leq e$ the derivative is positive if

$$\theta > \frac{1}{1 - \beta}. \quad (3.11)$$

In the case, the individual prefers work to leisure ($0 \leq h < y - p$), the individual chooses education, if the return to education is larger than the return to work α . For $0 \leq e < \frac{y}{\theta} - 1$ this is true for

$$\theta > 1. \quad (3.12)$$

For $y \leq \theta$ and $0 < \frac{y}{\theta} - 1 \leq e$ it holds for

$$\theta > \frac{1 + \alpha}{1 - \beta}. \quad (3.13)$$

As we have seen, the level of θ is very decisive for the decision of the individual. This makes it helpful to differentiate our analysis by the level of θ . As seen above, the following cases for θ have to be considered: $\theta \in (0, \frac{1}{1+\alpha}]$, $(\frac{1}{1+\alpha}, 1]$, $(1, \frac{1}{1-\beta}]$, $(\frac{1}{1-\beta}, \frac{1+\alpha}{1-\beta}]$ or $(\frac{1+\alpha}{1-\beta}, \bar{\theta}]$.¹¹ We start the analysis with the very lowly talented and proceed with increasing levels of ability. In each case, the return to education and work depends among other things upon their own levels (e and h). Hence, it is helpful to start the analysis for each case by setting the choice variables equal to zero. Then, we can compute the level up to which the individual can set the variable with the highest return (for $e = h = l = 0$) without changing the ranking in the attractiveness of the variables. If this level is smaller than 1, at least one of the other variables will also be positive in the optimum. In the following calculation of the variables, I always mention the variable with the highest return first, then the variable with the second highest return and finally the variable with the lowest return.

Case 1: $\theta \in (0, \frac{1}{1+\alpha}]$

For individuals with a very low ability it is never optimal to invest time in education. Even if they are worse off than the peer in their working life and have an additional incentive to learn by their inequity aversion, their return to education ($\theta(1 + \alpha)$) is still smaller than the return to leisure (see equation 1.1). If the individual is worse off than

¹¹In the following we assume $\bar{\theta} > \frac{1+\alpha}{1-\beta}$. As we will see time investment in education is always equal to one for $\theta > \frac{1+\alpha}{1-\beta}$. Hence, the exact level of the upper ability limit $\bar{\theta}$ does not play a role for the further analysis.

its peer in adolescence it prefers work to leisure to reduce its inequity aversion losses. If it is able to close the income gap to the peer by work in adolescence, it invests the rest of its time in leisure. Thus, the time investments are:

$$\begin{aligned} h &= \max \{0, \min \{1, y - p\}\}, \\ l &= 1 - h = \min \{1, \max \{0, 1 - y - p\}\}, \\ e &= 0. \end{aligned} \tag{3.14}$$

Case 2: $\theta \in (\frac{1}{1+\alpha}, 1]$

In this case, education would still be inefficient without inequity aversion. But, if the individual would be worse off than its peer in working life ($y > \theta$), education has a higher return than leisure ($\theta(1 + \alpha) > 1$), at least as long as the income gap in working life is not closed by education. But, if the individual is worse off than its peer in adolescence, it still prefers work to both education and leisure, because in this case the returns to work are largest ($1 + \alpha$). Therefore, the individual invests its time as follows:

$$\begin{aligned} h &= \max \{0, \min \{1, y - p\}\}, \\ e &= \max \{0, \min \{1, 1 - y + p, y/\theta - 1\}\}, \\ l &= 1 - h - e. \end{aligned} \tag{3.15}$$

Case 3: $\theta \in (1, \frac{1}{1-\beta}]$

Without inequity aversion it would now be optimal to choose only education. But, if increasing education leads to higher inequity in working life (individual is better off than its peer), this reduces the returns to education to $\theta(1 - \beta)$. Then leisure becomes superior to education. On the other hand, if the individual is worse off than its peer in adolescence and not worse off in working life, inequity aversion raises the return to work above the return to leisure and education ($1 + \alpha > 1 \geq \theta(1 - \beta)$). If the individual is worse off than its peer in working life, education is always optimal. In summary, the

individual will choose the following levels of time investment:

$$\begin{aligned} e &= \max \{0, \min \{1, y/\theta - 1\}\}, \\ h &= \max \{0, \min \{1, y - p, 2 - y/\theta\}\}, \\ l &= 1 - h - e. \end{aligned} \tag{3.16}$$

Case 4: $\theta \in (\frac{1}{1-\beta}, \frac{1+\alpha}{1-\beta}]$

In this case, the ability and with it the return to education is that large that the individual chooses education even if this creates larger inequity in working live. Hence, it will never choose leisure. The only possibility for work to be more attractive than education is that both work reduces inequity in adolescence and education increases inequity in working live ($\theta(1-\beta) < 1+\alpha$). In all other situation the individual chooses only education. To summarize the education choice in this case:

$$\begin{aligned} e &= \max \{\min \{1, 1 - y + p\}, \min \{1, y/\theta - 1\}\}, \\ h &= \max \{0, \min \{1, y - p, 2 - y/\theta\}\}, \\ l &= 0. \end{aligned} \tag{3.17}$$

Case 5: $\theta \in (\frac{1+\alpha}{1-\beta}, \bar{\theta}]$

This is the simplest case in the analysis. Ability is large enough to dominate all incentives not to learn induced by inequity aversion. Therefore, the clear outcome of the individuals maximization problem is

$$\begin{aligned} e &= 1, \\ h &= 0, \\ l &= 0. \end{aligned} \tag{3.18}$$

By analyzing these five cases, we have finished the formal calculation of the individual's education choice. In figure 3.1 one can see how an individual's investment in education, work and leisure¹² changes with its ability θ and parental spending p for some given

¹²In the figures investments are differentiated by colors. In areas with only one color the investment in the corresponding activity is equal to 1, in the other activities equal to 0. In areas with more than one color the time investment is divided between the corresponding activities. The more dominant a color in such an area is, the higher is the investment in the corresponding activity. But, I have to mention that the coloring is not everywhere absolutely precise.

parameters of inequity aversion α and β and peer's income y . The figure illustrates only one possible outcome and differs much, if y 's relative size in comparison to α and β changes. Further figures that depict outcomes for alternative values of y can be found in the appendix. In the next section we compare the education choice of inequity averse and purely self-interested individuals.

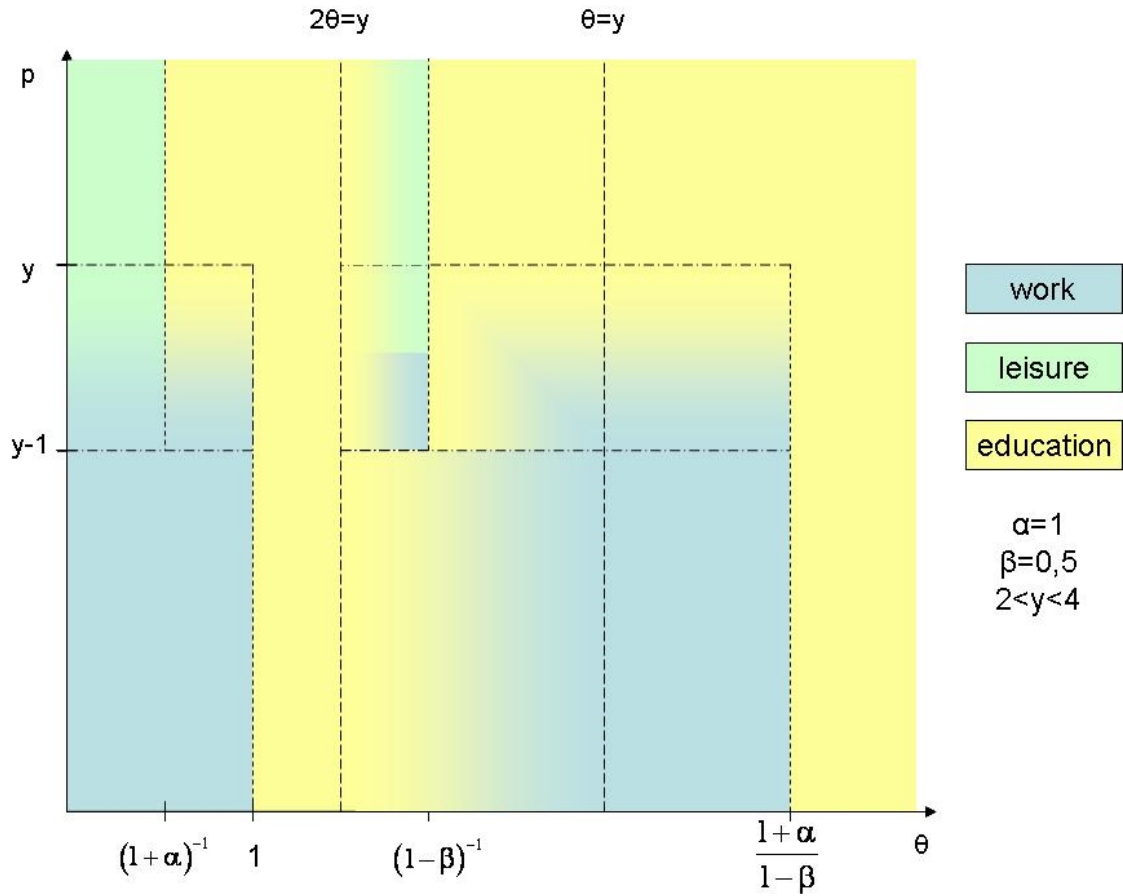


Figure 3.1: Education choice with a large peer income y

3.3 Inequity Aversion and its Effects on Education Choice

In this section we analyze how inequity aversion shapes my results and compare them to the results for purely self-interested individuals. We try to figure out how changes in the parameters of inequity aversion influence the results. Then, we discuss shortly whether the individual level of inequity aversion should be treated as something determined or

changeable in practical questions.

3.3.1 Inequity Aversion vs. Pure Self-Interest

In models of education choice with purely self-interested individuals time investment in education strictly increases with ability as long as future income increases with education. A very simple formalization¹³ of a purely self-interested individual's education choice is

$$U(e) = \theta e - \frac{1}{2}e^2 \quad (3.19)$$

where first best investment in education e^* is equal to ability θ (with wages per knowledge unit equal to 1). In my linear model a purely self-interested individual ($\alpha = \beta = 0$) would choose an investment in education equal to 0 for $\theta < 1$ and an investment equal to 1 for $\theta \geq 1$. How does inequity aversion ($\alpha, \beta > 0$) change this result? The most important outcome is that investment in education does not increase with ability anymore. For almost all possible vectors of the other exogenous parameters of the model (p, y, α, β) there exists an interval of θ in which investment in education decreases with θ . To make the analysis more precise it is useful to distinguish two cases: In the first case the individual's parents are relatively rich¹⁴ in comparison to its peer group ($p > y$), in the second case it is the other way round ($y > p + 1$).¹⁵

In the first case, the individual has no incentive to work in adolescence, as it is anyway better off than its peer group. Therefore, it has only to decide whether to invest in leisure or in education. If peer income is not extremely large or small ($y < (1 + \alpha)^{-1}$ or $y \geq 2(1 - \beta)^{-1}$), individuals with smaller values of θ ¹⁶ invest in education in comparison to purely self-interested ones. The result is caused by the additional incentives to learn induced by inequity aversion. If the individual would be worse off than its peer without education in working life, even lowly talented individuals decide to learn in order to reduce future inequity. But, with increasing ability less time has to be invested in education to equalize future income with the peer's income. When incomes are equalized, the additional incentives to learn do not only vanish, but altruism reduces

¹³For a more elaborated formalization of a purely self-interested individual's education choice see Bishop (2006). Also in his framework, in which many additional influences on education choice are considered, effort invested in education strictly increases with ability.

¹⁴In the following we call individuals whose parents are relatively rich in comparison to their peer group relatively rich individuals and proceed accordingly in the case of relatively poor parents.

¹⁵We analyze the case, in which a full time investment in work cannot close the income gap to the peer group in adolescence. The third case, in which the income gap can be closed ($p + 1 > y > p$), is a bit more complicated, but yields qualitatively the same results.

¹⁶ $(1 + \alpha)^{-1} < \theta \leq 1$

the incentives to invest more time in education. Thus, more talented¹⁷ individuals only invest that much time in education to equalize incomes and thereby investment in education decreases with ability in this interval. Highly talented individuals¹⁸ fully invest in education because their returns to education are large enough to compensate the reduction of incentives caused by inequity aversion. For extremely small or large peer incomes education increases with ability. In case of an extremely small peer income, only very untalented¹⁹ individuals have an additional incentive to learn because they are worse off than their peer group in working life. But, even with this additional incentive to learn leisure is still superior to education because of their very low ability. Hence, only individuals with $\theta > (1 - \beta)^{-1}$ invest in education, if peer income is extremely small. In case of an extremely large peer income, only very talented²⁰ can reach a higher income than their peer group in working life. But, as already mentioned, their ability is large enough to compensate the altruistic losses. Therefore, in case of extremely large peer incomes every individual with $\theta > (1 + \alpha)^{-1}$ invests all its time in education.

In the second case we analyze, the peer group's income is clearly larger than parental spending ($y > p + 1$). Then, work always dominates leisure, since even full time investment in work cannot close the income gap to the peer in adolescence. Thus, the return to work is always equal to $1 + \alpha$ in that case. For $\theta < 1$ work dominates education, because the return to education even with inequity aversion can only be $\theta(1 + \alpha)$. For $\theta \geq 1$ education dominates work if $y > \theta$ which means that without education the individual would be worse off than its peer in working life. In the case we are analyzing here, there is always a $\theta > 1$ for which education dominates work, as y is strictly larger than 1. The individual invests as much time in education as is necessary to equalize the own with the peer's income. If that is not possible, it invests its whole time endowment in education. But, similarly as in the first case, with rising ability less time investment in education is necessary to close the income gap to the peer and thereby investment in education decreases with ability in this interval. Exceptions, for which investment in education increases with ability, are as in the first case extremely small²¹ and large peer incomes. With the same argumentation as above this is the case for $y < (1 + \alpha)^{-1}$ and $y \geq \frac{2(1 + \alpha)}{1 - \beta}$. We sum up the results in a first proposition:

¹⁷ $1 < \theta \leq (1 - \beta)^{-1}$

¹⁸ $\theta > (1 - \beta)^{-1}$

¹⁹ $\theta < (1 + \alpha)^{-1}$

²⁰ $\theta > (1 - \beta)^{-1}$

²¹Only possible for $p + 1 \geq y > p$.

Proposition 3.1: *With inequity aversion $(\alpha, \beta > 0)$ and a representative peer's income y with $y \in ((1 + \alpha)^{-1}, 2(1 - \beta)^{-1})$ for $p > y$ or $y \in (1, \frac{2(1+\alpha)}{1-\beta})$ for $y > p + 1$ investment in education e is not increasing with ability θ .*

Proof. *See the Appendix.*

The upper analysis shows that individuals that are relatively rich in comparison to their peers invest on average more time in education than individuals that are relatively poor. The reason are the higher returns to work for the poor in comparison to the returns to leisure for the rich individuals. Thereby, opportunity costs of education for the relatively poor individuals are larger than for the relatively rich individuals. We state this result as a proposition here and will discuss it in more detail in section 3.4 of this chapter.

Proposition 3.2: *All other parameters (α, β, y) constant, relatively rich individuals ($p > y$)²² invest on average (over θ) strictly more time in education than relatively poor individuals ($p < y$). For a given ability θ relatively rich individuals invest at least as much time in education as relatively poor individuals.*

Proof. *See the Appendix.*

The next question we try to answer is whether inequity averse individuals tend to invest on average more or less time in education than purely self-interested individuals. We have observed up to now that inequity averse individuals with low ability more often invest in education than purely self-interested individuals, while inequity averse individuals with high ability on average invest less time in education. Caused by the multiplicity of potential cases it is unfortunately not feasible to give a clear characterization under which circumstances (parameter values) average²³ investment in education is larger or smaller than with purely self-interested individuals. But, if we again use the differentiation between relatively rich ($p > y$) and relatively poor ($y > p + 1$) individuals, we get clearer results. For relatively rich individuals the overall effect of inequity aversion is ambiguous. On the one hand, the larger α (envy), the more relatively rich ones invest in education.²⁴ On the other hand, the larger β (altruism), the less highly talented invest in education, since they suffer more from

²²We have to assume some arbitrarily large, but finite upper limit \bar{p} to ensure that differences on finite intervals of p have an effect on average investment in education.

²³over the level of ability

²⁴The larger α , the more lowly talented are motivated to learn, because their future losses induced by envy increase.

being better off than their peers in future. Which of the both effects dominates can not be answered in general and depends on the relative size of α in comparison to β . For relatively poor individuals the effect of inequity aversion is unambiguous. They on average invest less time in education. Since their incentives to work are quite large ($1 + \alpha$), they will never invest in education for $\theta < 1$. This is the same threshold as for purely self-interested individuals. But, purely self-interested individuals invest all their time in education for $\theta \geq 1$. This is not the case for relatively poor individuals with inequity aversion.²⁵ They suffer from being better off than their peers and invest for $\theta \in [1, \frac{1+\alpha}{1-\beta})$ only that much time in education to equalize their income with the peer's income in working life. As this interval increases with α and with β , both envy and altruism reduce the (average) investment in education of relatively poor individuals. Envy increases the opportunity costs of education, because it increases returns to work in adolescence and altruism reduces the returns to education in the case the individual can be better off than its peers by choosing a high level of education. Therefore, there are less individuals that invest in education than in the case of purely self-interested individuals. The results are summarized in the following proposition:

Proposition 3.3: *For relatively rich individuals ($p > y$) it is ambiguous whether they invest (on average) more time in education with inequity aversion ($\alpha, \beta > 0$) or without inequity aversion ($\alpha, \beta = 0$). Their average investment in education increases with envy α , but decreases with altruism β . Relatively poor individuals ($y > p + 1$) invest on average strictly less time in education with inequity aversion. Their average investment in education decreases both with envy α and altruism β .*

Proof. *See the Appendix.*

Finally, we turn our attention to the role of the peer's income. To analyze how an increasing peer income influences the individuals' investment in education, we make the assumption that the parental spending p is uniformly and symmetrically distributed around the representative peer's income y . This is a benchmark case as the peer income is equal to the expected value of parental spending. Thereby, an increasing peer income does not change the probability of being better or worse off in adolescence, while it raises (reduces) the probability of being worse (better) off in working life. Nevertheless, as a positive correlation between parental and peer income seems plausible, it is worthwhile to analyze this benchmark case. As its incentives to get educated are increased if an individual is worse off in working life, inequity averse

²⁵As long as $y < 2 \cdot \frac{1+\alpha}{1-\beta}$.

individuals on average invest more time in education the larger the peer's income. With a smaller, but positive correlation between parental and peer income the positive effects of an increasing peer income would still exist, but be reduced by an increasing probability of being worse off in adolescence. Before we start with a new section, we summarize these last results in a forth proposition:

Proposition 3.4: *If parental income p is uniformly and symmetrically distributed around the representative peer's income ($p \sim U(y - a, y + a)$ with $a < y$), the average (time) investment in education of inequity averse individuals ($\alpha, \beta > 0$) increases with the representative peer's income y .*

Proof. *See the Appendix.*

In this section we showed how strongly inequity aversion changes the outcome of an individual's education choice. I think these new insights should not be neglected in the theoretical analysis of educational problems. For the question which recommendations for practical problems can be deduced from my results, it is important to clarify whether one treats inequity aversion as something predetermined or something that can be modified by exogenous influences. We discuss this question in the next section.

3.3.2 Inequity Aversion - Determined or Changeable?

As we have seen, the introduction of inequity aversion into a model of education choice changes the results of such a model significantly. From a perspective that aims at an efficient education system, in which highly talented invest much in education, while lowly talented invest less, inequity aversion distorts the outcome of education choice away from the optimum. But, it is also clear, that the individuals in my model behave totally rational and optimize their individual investment in education and thereby their individual welfare. Thus, taking the variables α , β , y and p as given, there is no possibility for education policy or parents to reduce the distortion in the children's education choice. In this section we will briefly discuss whether the inequity aversion parameters α and β should be taken as determined or changeable. The discussion how the variables y and p effect education choice follows in the next two sections of this chapter.

In the literature about inequity aversion it is shown that α and β are heterogeneously distributed over population (Fehr and Schmidt 1999). Where inequity aversion

comes from and how it is individually determined has not been focus of research up to now. Because of the variation of social preferences within societies, I believe that the individual level of inequity aversion can be at least partly influenced by parental education. Parents can promote values to their children and envy and altruism are surely two values parents are interested in. In my opinion, both values can be promoted independently. Parents can educate children to be very altruistic, envious or both. Also across societies there is evidence for variation of social preferences. Henrich et al. (2001) show the importance of economic and social environment for social preferences in a cross-cultural study. They find a strong behavioral variability in games with social interaction across 15 small-scale societies. Group-level differences in economic organization and the degree of market integration explain a substantial portion of the behavioral variation across these societies. Therefore, I think that societies can promote values mainly indirect by setting economic or social frameworks that award envious, altruistic or self-interested behavior.

Before we close this section, we point out what the result of a change in the parameters would be. Proposition 3.3 tells us that an increase in envy would increase the investment in education of relative rich individuals and would reduce the investment of relative poor individuals in education. An increase of altruism unambiguously decreases the investment in education. Whether and how parents and especially society could and should influence the parameters, we will discuss in detail in section 3.6.

3.4 Family Background

Empirical evidence suggests that family background is an important determinant of a child's educational success. Robertson and Symons (2003) show that both parental social class and parental academic achievement have strong positive effects on academic attainment. Similarly, Fuchs and Wößmann (2006) find that many family characteristics have an influence on a student's educational performance. Performance e.g. increases with the parents' level of education and is larger if parents have a white rather than a blue collar job. Solon (1992) finds a strong intergenerational income correlation for the United States. As long as one thinks that income is correlated with education this finding supports the positive correlation between parents' income and children's educational success. Mulligan (1997) estimates both intergenerational correlation of wealth and of earnings. He finds that the correlation coefficients for consumption and total income fall in the 0.7-0.8 range, while the intergenerational correlation of earnings

is about 0.5.

As empirics find a positive intergenerational income correlation it is up to theory to find a convincing explanation for it. Piketty (2000) gives an excellent summary of the most prominent theoretical explanations for persistent inequality and intergenerational mobility. One possible explanation for intergenerational income correlation could be the high costs of education, especially in the US, combined with imperfect capital markets. If that was the main reason for intergenerational income correlation, this correlation should be very low in many European countries where even higher education is mainly for free. But, Bjorklund and Jantti (1997) show that there is also a strong intergenerational income correlation in Sweden, a country in which, e.g., tuition fees are not allowed. A very obvious channel explaining why inequality can persist across generations is the transmission of wealth from parents to children through inheritance. But with regard to the results of Mulligan (1997), wealth transmission cannot explain the intergenerational correlation of earnings (0.5), but only the additional part (0.2-0.3) in the intergenerational correlation of wealth. A further explanation for the intergenerational correlation of earnings could be the family transmission of ability. Transition of ability can both mean genetic and cultural transmission. Plug and Vijverberg (2003) try to estimate how much of all ability relevant for schooling is genetically passed on. They find that at least 50 percent of ability is genetically transmitted. Otherwise, Sacerdote (2002) shows that being raised in a family with a high socioeconomic status greatly increases the probability to attend college also for adoptees. A theory closely related to mine is the reference group theory formulated by Merton (1953) and Boudon (1974). According to this theory, the intergenerational persistence of labor earnings inequality follows from the intergenerational transmission of ambition and taste for economic success. While the story behind this theory is very similar to mine, the formalization is quite different. They state that agents care to maintain their social status. Thereby, agents with upper-class origins have higher incentives to be successful on the labor market than agents with lower-class origins. But, by stating that agents care to maintain their social status, the result that upper-class origins are more successful in education is introduced more or less by assumption. Other explanations for the importance of family background in education choice are imperfect capital markets,

local segregation²⁶ and self-fulfilling beliefs²⁷.

I do not want to state that the mentioned explanations for the importance of family background are wrong or not important in reality. But, my model provides an alternative and, as I think, convincing explanation, why family background plays an important role in education choice. My explanation's advantage is the minor use of education specific assumptions. We just introduce an established utility function (Fehr and Schmidt 1999) into an education choice model and can show that having relatively rich parents improves a student's academic attainment.

There are two channels how family background influences education choice in my model. Both are driven by the relative position of an individual in comparison to its peers. The first channel works through the individual's relative position in adolescence. This relative position is mainly determined by parental income. If an individual is better off than its peers, it can concentrate on education. An individual that is worse off than its peers has an incentive to work to reduce its losses induced by inequity aversion. Thereby its education choice is downward biased in comparison to relatively rich individuals. This result does not say anything about the effect of the absolute level of parental income on education choice, but I think it is reasonable to assume that the probability of being better off than one's peers increases with parental income. But it can obviously well be the case that someone with poor parents is relatively rich in comparison to his peers, while someone with rich parents can be relatively poor in comparison to his peers. To get a second effect of parental income on education choice, one needs the additional assumption that peers' income is positively correlated with parental income as in proposition 3.4.²⁸ This seems to be absolutely plausible as peer groups typically consist out of friends in the neighborhood, schoolmates and relatives. For all of this groups one should observe (at least a week) positive correlation of income with an individual's parental income. With this assumption individuals with rich parents have a higher incentive to learn, as they want to avoid to be worse off than their rich peers in working life. In contrast, individuals with a poor background do

²⁶Benabou (1993) develops a model in which both costs of high education and of low education depend negatively on the fraction of one's neighbors choosing to obtain a high education (positive external effects of education). If the external effects on the costs of high education are larger than on the costs of low education, housing prices in a high education area are larger and segregation into a rich neighborhood with high education and a poor neighborhood with low education takes place.

²⁷If, e.g., one group in the society is discriminated on the labor market, their incentives to invest in education are reduced and they get on average less educated than the not-discriminated. Then, the employers observe their smaller educational level and their discriminatory beliefs are reconfirmed.

²⁸This assumption obviously reduces the effect in adolescence we just described. But, as long as this correlation is smaller than 1, the first effect would not disappear.

not suffer that much from being poor in working life, since their peers are poor, too. Therefore, their average effort in education is smaller in comparison to individuals with a rich background.

In this section, we tried to show that the introduction of inequity aversion into an education choice model provides an alternative explanation for the empirically established importance of family background for educational achievement. Our explanation focuses on a student's incentives and not on his exogenous opportunities. I think that my model's advantage is its simple structure and the small number of assumption that has to be made. In the next section we discuss where peer effects in school come from and whether my model provides new explanations for the existence of these peer effects.

3.5 Peer Effects

In this section we discuss peer effects. The empirical literature suggests that having 'good' classmates and friends improves a students' academic attainment. What being a 'good' student means is not totally clear in the empirical literature and we will discuss it in the further analysis. While there are many empirical studies, theoretical explanation for the existence of peer effects are rare. In the next section of this chapter, we will summarize the empirical evidence concerning peer effects in school. Then, we will analyze whether my model can provide a convincing theoretical explanations for peer effects and discuss how other theoretical approaches explain these effects. We are mainly interested in a student's education choice at the microlevel and analyze how the composition of a group of students can endogenously determine their motivation and attitude.

3.5.1 Empirical Evidence

As already mentioned there exists a lot of empirical research on peer effects. We concentrate only on a few of these studies, which we consider to be the most important ones for the analysis of a student's education choice at the microlevel.

As one of the first studies on this topic, Simpson (1962) analyzes the academic ambitions of students with a working class and with a middle class background. His empirical analysis suggests that both peers and parents have an influence on students ambitions. The more middle class peers a middle-class or working-class student has, the higher are his occupational aspirations. But, not only the peers' social background

is important, also their aspirations play a role. The more peers with high aspirations a student has the higher are his own aspirations. Therefore, it cannot be distinguished by Simpson's results whether peers' aspirations or peers' social status increase a student's own aspirations.

Sacerdote (2001) shows that not only aspirations but also academic outcomes are influenced by peers. He analyzes a data set on first year students from Dartmouth College that are randomly assigned to share a room.²⁹ Even within this group of highly selected college age students he finds a strong correlation between the grade point averages of roommates. Where this correlation comes from cannot be derived from the data. It could both be a knowledge spillover or a mutual motivation.

Hoxby (2000) and Hanushek et al. (2003) analyze peer effects in the classroom. Both find a positive influence of peer achievement on student achievement. As an interesting result Hoxby finds that peer effects are stronger intra-race. From my point of view this indicates that peer effects are not only spill-over effects, but depend also on the personal relationship between students. If one believes that there are more intra- than inter-race friendships in school and students take friends as reference points, the fact that peer effects are stronger intra-race would confirm the results of my model.

A further paper that underlines the importance of peer groups is Robertson and Symons (2003). They find strong evidence that having classmates coming from higher socioeconomic groups improves the academic attainment of students. As the studies above, they are not able to trace the channel by which the peer group influences attainment. As an interesting result they find diminishing returns to average peer quality. Additionally they analyze differences in peer effects in schools with and without streaming (also called tracking or ability grouping). They find that those placed in the top stream benefit from attending streamed schools, while most of the students placed in the low ability stream suffer from attending a streamed school. Within the students placed in the top stream, those with lowest ability profit most, while in the low ability stream those with the highest ability suffer most. Interestingly, the best students in the top stream hardly benefit from attending a streamed school. This seems to indicate that for the explanation of peer effects relative positions within a group of students are more important than the average level of ability. Otherwise the positive effect of being in the top stream should be the same for all students in that group. Other empirical

²⁹A similar analysis has been done by Zimmerman (2003). He analyzes data from Williams College and gets comparable results.

studies³⁰ on streaming have more mixed results. While most of the studies find that high-ability students gain from streaming and low-ability students suffer from streaming, the evidence which students in each ability group suffer or gain is mixed. Hence, some of results of Robertson and Symons (2003) are still controversial in the literature.

All the above mentioned approaches and most of the further literature have in common that peers influence a student's educational attainment or aspiration. How the peers influence each other is empirically difficult to detect. In the next section we try to find a convincing theoretical explanation for the peer effects.

3.5.2 Theoretical Explanations

As we saw in the last section, it seems to be an empirical fact that having 'good' peers in a class or as friends improves a child's academic attainment. What this 'good' means is not that clear. It varies from peers' parental characteristics like socioeconomic class, occupational status, aspirations and education to peers' characteristics like grades, abilities and aspirations. Since many of these variables are highly correlated, it seems empirically hardly possible to identify the decisive variable. It could also well be that several of these variables contribute to the peer effects. In this section we want to discuss the way these variables influence a child's academic performance. Are peers somehow exogenously transferring ability or knowledge to the child or do they endogenously influence its education choice? An exogenous spillover explanation could only be that a child profits from spending time with 'good' peers inside or outside class. With regard to the empirical studies mentioned above it seems to be more plausible that peers are shaping an individual's education choice. Peers can be role models, confirm or subvert motivation or, as in my model, be reference points.

The advantage of my model is its general setting. The utility function is not tailored for the specific topic we deal with. But, the other side of the coin is that the model misses some specific aspects that are probably important for the peer group effects in school. The main problem of my model in the school context is the exogenous peer income. While, as we argued in section 3.2, the peer group's income in adolescence and working live is positively correlated and thereby our assumption of a constant peer income is a useful benchmark for the analysis in section 3.4, it is only partly convenient in this context. To support my model one could argue that having more peers in class

³⁰See, e.g., Argys et al. (1996), Betts and Shkolnik (2000), Figlio and Page (2002), Galindo-Rueda and Vignoles (2003), Meghir and Palme (2005), and Hanushek and Wößmann (2006).

with parents from high socioeconomic groups increases an individual's average peer group income. As average investment in education tends to increase with peer's income in my model (compare benchmark figures 3.2 and 3.6), one would observe a positive effect of 'good' peers on academic attainment. Unfortunately, we cannot prove this result in general, but rather need the assumption that parental income is uniformly and symmetrically distributed around peer income (see Proposition 3.4). Without this assumption, there can well be intervals of y in which average investment in education decreases with the peer's income. What is missing in my model and probably important in the school context, is the interaction of students.³¹ In my opinion inequity aversion plays an important role in these interactions and it is left to future research to analyze this question in a formal way. What we can state here is that on the one hand having well performing peers in class provides inequity averse students additional incentives to invest in education. On the other hand having bad peers in class reduces the incentives to invest in education for students. To support this statement one can argue in two ways. Firstly, students could not only care for material inequity, but also suffer from inequity in other performance measures like in this case grades. Secondly, from a more economic perspective, grades in school can be interpreted as signals for future success on the labor market. A student with well performing peers in class gets the signal that he will have (relatively) little success on the labor market in comparison to his peers. If he is inequity averse, this signal makes him to invest more time in education. The opposite is true for a student with badly performing peers in class. He gets the signal that he will have more success than his peers in working life, hence inequity aversion reduces his incentives to invest in education.

With this line of argumentation one can explain the above mentioned empirical results concerning schools with and without streaming by Robertson and Symons (2003). With inequity aversion it is obvious that the effect of streaming is largest for those students who are located close to the threshold level that decides whether students are sorted into the high- or the low-ability stream.³² In an unstreamed school these students have an average ability and thus are hardly influenced by their inequity aversion. In a streamed school those placed in the low ability stream are the best students in their group and their inequity aversion reduces their incentives to invest in education.

³¹A model developed by Lazear (2001) reflects how students could influence each other by disrupting the class. From my point of view his approach is only partly convenient as a student's disruption probability defines whether he is a good or bad student. Then, it is optimal to segregate good from bad students. In such a framework it would be interesting to link a student's and his peers' ability with his probability to disrupt the class. Then, one would get clearer arguments for or against segregation.

³²If the students are divided into two groups.

Those placed in the top stream are the worst students in their group and their incentives to invest in education are increased by inequity aversion. Those students who were already among the best (worst) students in the unstreamed school do hardly face changes in their incentives, if they attend a streamed school. Their relative position in the class stays the same as they are still among the best (worst) students.

Before finishing this section we want to mention an approach that formalizes a related idea about interaction of students in school. Akerlof and Kranton (2002) build a model in which students are not only interested in their academic attainment, but also seek to behave in line with their personal identity. As insights from sociology suggest, students in Akerlof and Kranton's model can choose one of three identities in school. Depending on their own abilities students decide to become a 'jock', 'nerd' or 'burnout'. Each of this group has its own identity, which every member of a group wants to meet. Thus, this identity biases the education choice of each group member in the same direction and thereby reduces inequity within these three groups of students. The close connection to the theory of inequity aversion is obvious. From my point of view this approach goes in the right direction, but it has quite restrictive assumptions that yield the results. It takes the existence of the three (or more) mentioned identities as given. Every student has to take one of the identities as his ideal. It is natural that the model has the outcome of three different groups of students that tend to behave in line with their chosen identity. What is missing is a justification why there should not be other identities and most important where these identities come from. It would be interesting to develop a model that can explain why students tend to sort into such groups and how identities are generated in a class.³³ Not surprisingly, I suggest that inequity aversion could help to explain these observations. If one can choose its own reference group it is natural to select similar students as peers as this minimizes losses induced by inequity aversion.

3.6 Education Policy

Education policy is a complicated task in many ways. While there are some factors that directly and in an objective way influence the quality of education (e.g. quality of teachers, teaching methods, design of exams), many other issues are complicated to deal

³³Bishop et al. (2004) develop a model about student culture and norms and thereby try to explain the tendency to conformity within some schools. Students harass better students to reduce the better students' academic attainment because they want to improve their academic rank in school. Thereby they want to increase their expected future income and self-esteem.

with. The first problem one has to solve is the formulation of the objectives of education policy. Should policy aim at the maximization of average academic attainment or at education efficiency from an individual point of view, which would mean that the marginal return to education equals the marginal cost of education? Should education policy try to support weaker students or to build an elite? But, there is at least one objective most people agree on: Academic and occupational success should not depend on parental wealth and social background. As my model provides mainly insights into this topic, we will concentrate our discussion on this issue.

What drives the social differences in educational outcomes in my approach is the envy of the relatively poor individuals in adolescence. Since it is not in the scope of education policy to reduce the inequality in the parental generation, politicians could act in two directions. They could try to reduce either the inequity aversion of students (if that is possible) or the subjective perception of inequity. What do we mean by that? As we argued in section 3.3, we think that envy and altruism are at least in parts a product of education and economic and social environment. While the government can hardly influence the values parents promote to their children, it can decide which values are promoted at school. Concerning the subjective perception of inequity, there can be several ways to reduce it at school. The installation of all-day schools for example reduces the amount of decisions a student has to take that depend on his income. If e.g. sportive and cultural activities would be offered at school free of charges, every student would have the same opportunities to spend his free time and inequity would be reduced. An alternative way to reduce subjective inequity is the introduction of school uniforms. If school uniforms are introduced and (electronic) consumption goods like mobile phones are not allowed at school, the importance of (parental) income as a source of inequity at school (and in life) would be reduced. While these instruments can reduce inequity and thereby the distortion in education choice, one needs always to keep in mind, that these instruments can have effects on other things that we are not dealing with here. They have, e.g., the price of a reduced level of freedom and self-determination of students. But, if the aim is a reduced distortion in education choice induced by inequity aversion, they seem to lead in the right direction.

As a last point we want to discuss the role of parents. In my model their income is just an exogenous parameter, that influences individuals' relative income in comparison to their peers' income in adolescence. In my model we normalized the share of parental income that is spent on children to 1. But in general, parents should be able to at least partly influence the share of their income they spend on their child. Therefore, if the parents of a group of students can and want to equalize their parental spending

on their children, they can reduce or even eliminate the distortion in their children's education choice induced by inequity aversion.

3.7 Conclusion

My model offers a new way to analyze individuals' education choice. With the integration of inequity aversion into a simple education choice framework, we can explain the empirically proven persistence of intergenerational income inequality and give new insights into the functionality of peer effects. The education choice of inequity averse individuals deviates systematically from the education choice of purely self-interested individuals. Inequity averse students who are in adolescence relatively poor in comparison to their peer group invest less time in education than students who are relatively rich in comparison to their peers. The reason for relatively poor students to choose less education are their higher opportunity costs of education. If they work in adolescence, they can reduce the income gap in comparison to their peers and thereby reduce their losses induced by inequity aversion. For inequity averse individuals it is also no longer true that investment in education strictly increases with ability. For almost all exogenous parameter values of my model, there are intervals of ability in which investment in education decreases with ability. Having a rich peer group in working life gives additional incentives to choose a high level of education, while having a poor peer group in working life reduces the incentives to choose a high level of education. I think that these new insights into an individual's education choice should be reflected in the analysis of education policy and the discussion of efficient education systems.

My approach is only one possible way to integrate inequity aversion into an education choice model. I see it as a starting point for future research. While in my model the peer group's income is exogenous, it would be more realistic for some specific questions to build a model with interactions between two or more students. We described in section 3.5 of this chapter how such a model could look like. If a student compares her grades or behavior with other students and is inequity averse, such a model would explain the empirical finding that students' academic attainment profits from having good classmates and suffers from having bad classmates. Other empirical results about the effects of streaming in school (Robertson and Symons 2003) could as well be explained with such an approach.

3.8 Appendix

3.8.1 Proofs

Proof of Proposition 3.1:

For several cases it has to be shown that the time investment in education e is not increasing with ability θ :

a) For $p > y$

i) and $y < (1 - \beta)^{-1}$:

$\exists \hat{\theta}$ with $(1 + \alpha)^{-1} < \hat{\theta} < y$. As by assumption $y < (1 - \beta)^{-1} \Rightarrow \hat{\theta} < (1 - \beta)^{-1}$. For $p > y$ we know that $\frac{\partial U}{\partial h} < \frac{\partial U}{\partial l} = 1, \forall \theta$. As $(1 + \alpha)^{-1} < \hat{\theta} < y \Rightarrow \frac{\partial U(\hat{\theta})}{\partial e} \stackrel{for e=0}{=} (1 + \alpha)\hat{\theta} > 1 \Rightarrow$ for $\hat{\theta}$: $e > 0$ in the optimum. But, $\exists \tilde{\theta} > \hat{\theta}$ with $y < \tilde{\theta} < (1 - \beta)^{-1} \Rightarrow \frac{\partial U(\tilde{\theta})}{\partial e} \stackrel{for e=0}{=} (1 - \beta)\tilde{\theta} < 1 \Rightarrow$ for $\tilde{\theta}$: $e = 0$ in the optimum.

ii) , $y > (1 - \beta)^{-1}$, and $\frac{y}{2} > \frac{1}{1+\alpha}$:

$\exists \hat{\theta} = \frac{y}{2}$ with $\hat{\theta} < (1 - \beta)^{-1}$. As $\hat{\theta} = \frac{y}{2} \Rightarrow \frac{\partial U(\hat{\theta})}{\partial e} > 1, \forall e < 1 \Rightarrow e = 1$ in the optimum. But, $\exists \tilde{\theta} > \hat{\theta}$ with $\tilde{\theta} < (1 - \beta)^{-1}$ and $\tilde{\theta}(1 + \tilde{e}) = y$ with $\tilde{e} < 1$ as $\tilde{\theta} > \frac{y}{2}$. For $\forall e > \tilde{e}$ holds $\frac{\partial U(\tilde{\theta})}{\partial e} = (1 - \beta)\tilde{\theta} < 1 \Rightarrow$ for $\tilde{\theta}$: $e = \tilde{e} < 1$ in the optimum.

iii) , $y > (1 - \beta)^{-1}$, and $\frac{y}{2} < \frac{1}{1+\alpha}$:

$\exists \hat{\theta}$ with $\frac{1}{1+\alpha} < \hat{\theta} < 1 < y \Rightarrow \frac{\partial U(\hat{\theta})}{\partial e} \stackrel{for e=0}{=} (1 + \alpha)\hat{\theta} > 1$ and $\frac{\partial U(\hat{\theta})}{\partial e} \stackrel{for e=1}{=} (1 - \beta)\hat{\theta} < 1 \Rightarrow$ for the optimal \hat{e} : $\hat{\theta}(1 + \hat{e}) = 1$. But, $\exists \tilde{\theta} > \hat{\theta}$ with $\tilde{\theta} < 1$ and optimal \tilde{e} determined by $\tilde{\theta}(1 + \tilde{e}) = 1$. As $\tilde{\theta} > \hat{\theta} \Rightarrow \tilde{e} < \hat{e}$.

b) For $y > p + 1$

i), $\frac{y}{2} < 1$, and $y < \frac{1+\alpha}{1-\beta}$:

$\exists \hat{\theta}$ with $1 < \hat{\theta} < y$. For $y > p + 1$ we know that $\frac{\partial U}{\partial l} < \frac{\partial U}{\partial h} = 1 + \alpha, \forall \theta$. As $1 < \hat{\theta} < y \Rightarrow \frac{\partial U(\hat{\theta})}{\partial e} \stackrel{for e=0}{=} (1 + \alpha)\hat{\theta} > 1 + \alpha \Rightarrow e > 0$ in the optimum. But, for $\tilde{\theta} = y > \hat{\theta}$ holds $\frac{\partial U(\tilde{\theta})}{\partial e} \stackrel{for e=0}{=} (1 - \beta)\tilde{\theta} < 1 + \alpha$ as $\tilde{\theta} = y < \frac{1+\alpha}{1-\beta} \Rightarrow e = 0$ in the optimum.

ii), $\frac{y}{2} < 1$, and $y > \frac{1+\alpha}{1-\beta}$:

Choose $1 < \hat{\theta} < \tilde{\theta} < \frac{1+\alpha}{1-\beta}$. Then, similarly as in a) iii) the optimal \hat{e} and \tilde{e} are determined by $(1 + \hat{e})\hat{\theta} = (1 + \tilde{e})\tilde{\theta} = y \Rightarrow \hat{e} > \tilde{e}$.

iii), $\frac{y}{2} > 1$, and $y < 2(\frac{1+\alpha}{1-\beta})$:

$\exists \hat{\theta}$ with $\hat{\theta} = \frac{y}{2} < \frac{1+\alpha}{1-\beta}$. As $\hat{\theta} = \frac{y}{2} \Rightarrow \frac{\partial U(\hat{\theta})}{\partial e} = (1 + \alpha)\hat{\theta} > 1 + \alpha, \forall e < 1 \Rightarrow e = 1$ in the optimum. But, $\exists \tilde{\theta} > \hat{\theta}$ with $\tilde{\theta} < \frac{1+\alpha}{1-\beta}$ and $\tilde{\theta}(1 + \tilde{e}) = y$ with $\tilde{e} < 1$ as $\tilde{\theta} > \frac{y}{2}$. For $\forall e > \tilde{e}$ holds $\frac{\partial U(\tilde{\theta})}{\partial e} = (1 - \beta)\tilde{\theta} < 1 + \alpha \Rightarrow$ for $\tilde{\theta}$: $e = \tilde{e} < 1$ in the optimum.

q.e.d.

Proof of Proposition 3.2:

As the constraint $l + h + e < 1$ is always binding (see equation (3.4)) and both $\frac{\partial U(\theta)}{\partial l}$ and $\frac{\partial U(\theta)}{\partial e}$ are independent of whether $(p > y)$ or $(p < y)$, $\frac{\partial U(\theta)}{\partial h}$ as opportunity costs of education are decisive for the difference in the time investment in education of relatively rich in comparison to relatively poor individuals. As $\frac{\partial U(\theta)}{\partial h}$ for $(p > y) \leq \frac{\partial U(\theta)}{\partial h}$ for $(p < y)$, $\forall \theta \Rightarrow e(p > y) \geq e(p < y)$, $\forall \theta$.

Additionally, it is to show, that there is always a θ with $e(p > y) > e(p < y)$. Two cases have to be distinguished:

a) $y < 2(\frac{1+\alpha}{1-\beta})$:

For $\forall \theta > (1 - \beta)^{-1}$, $p > y$ and $e \in [0, 1]$: $\frac{\partial U(\theta)}{\partial e} > 1 \Rightarrow e = 1$ in the optimum. For $\forall p < y \exists \hat{\theta}$ with $(1 - \beta)^{-1} < \hat{\theta} < (\frac{1+\alpha}{1-\beta})$ and $\hat{\theta} > \frac{y}{2}$. As $\hat{\theta} > \frac{y}{2} \Rightarrow \forall e > \hat{e}$ with $(1 + \hat{e})\hat{\theta} = y$: $\frac{\partial U(\hat{\theta})}{\partial e} = (1 - \beta)\hat{\theta} < (1 + \alpha) = \frac{\partial U(\hat{\theta})}{\partial h} \Rightarrow h > 0 \Rightarrow e < 1$ in the optimum.

b) $y > 2(\frac{1+\alpha}{1-\beta})$:

As $y > 2(\frac{1+\alpha}{1-\beta}) \Rightarrow y > 2 \Rightarrow$ i) For $\forall \theta$ with $(1 + \alpha)^{-1} < \theta < 1$, $p > y$ and $e \in [0, 1]$: $\frac{\partial U(\theta)}{\partial e} = (1 + \alpha)\theta > 1 = \frac{\partial U}{\partial l} > \frac{\partial U}{\partial h} \Rightarrow e = 1$ in the optimum. ii) For $\forall p < y$ and $\forall \theta$ with $(1 + \alpha)^{-1} < \theta < 1$: $\frac{\partial U(\theta)}{\partial h} \stackrel{\text{for } h=0}{=} (1 + \alpha) > (1 + \alpha)\theta = \frac{\partial U(\theta)}{\partial e} \Rightarrow h > 0 \Rightarrow e < 1$ in the optimum.

q.e.d.

Proof of Proposition 3.3:

a) Increase of (average) investment in education with α for $p > y$:

For $p > y$ and $y > (1 + \alpha)^{-1}$: $\forall \theta < 1$ with $(1 + \alpha)^{-1} < \theta < y \Rightarrow e > 0$ with $(1 + e)\theta = y$ if $2y < \theta$ or $e = 1$ if $2y \geq \theta \Leftrightarrow e = \min\{\frac{y}{\theta} - 1, 1\} \Rightarrow$ (if α increases $\Rightarrow (1 + \alpha)^{-1}$ decreases \Rightarrow the interval determining the θ 's that invest in education increases (for $\theta < (1 + \alpha)^{-1}$: $e = 0$). The optimal e stays the same for the other θ 's). For $p > y$ and $y < (1 + \alpha)^{-1}$ the investment in education is independent of α .

b) Decrease of (average) investment in education with β for $p > y$:

For $p > y$ and $\frac{y}{2} < (1 - \beta)^{-1}$: $\forall \theta > (1 - \beta)^{-1} \Rightarrow \frac{\partial U(\theta)}{\partial e} > 1$, $\forall e \Rightarrow e = 1$ in the optimum. If β increases $\Rightarrow (1 - \beta)^{-1}$ increases \Rightarrow less θ fully invest in education (for $\frac{y}{2} < \theta < (1 - \beta)^{-1}$: $e < 1$ as then $\frac{\partial U(\theta)}{\partial e} \stackrel{\text{for } e=1}{<} 1$). For $p > y$ and $\frac{y}{2} > (1 - \beta)^{-1}$ the investment in education is independent of β .

c) Decrease of (average) investment in education with α for $p + 1 < y$:

For $p + 1 < y$ and $\frac{y}{2} < (\frac{1+\alpha}{1-\beta})$: $\forall \theta > (\frac{1+\alpha}{1-\beta}) \Rightarrow e = 1$ as $\frac{\partial U(\theta)}{\partial e} > (1 + \alpha)$. $\forall \theta$ with $\frac{y}{2} < \theta < (\frac{1+\alpha}{1-\beta}) \Rightarrow e < 1$ as $\frac{\partial U(\theta)}{\partial e} \stackrel{\text{for } e=1}{<} (1 + \alpha)$. If α increases $\Rightarrow \frac{1+\alpha}{1-\beta}$ increases \Rightarrow less θ fully invest in education. For $\frac{y}{2} > (\frac{1+\alpha}{1-\beta})$ the investment in education is independent of α .

d) Decrease of (average) investment in education with β for $p + 1 < y$:

Same proof as in c), only that $(\frac{1+\alpha}{1-\beta})$ in this case increases with β .

q.e.d.

Proof of Proposition 3.4:

We prove separated for a) $p \in (y, y + a]$ and b) $p \in [y - a, y - 1]$ (for $a > 1$) that average investment in education \bar{e} increases with y . If that is shown, it must also be the case that for $p \in [y - a, y]$ for $a < 1$ or $p \in (y - 1, y]$ for $a > 1$ average investment in education \bar{e} increases with y , as the incentives known from the first two cases just overlap in the third case.

a) For $p \in (y, y + a]$ and

i) $y < (1 + \alpha)^{-1}$: $e = 0$ for $\theta < (1 - \beta)^{-1}$ and $e = 1$ for $\theta \geq (1 - \beta)^{-1}$. Average investment in education (over all $\theta < \frac{1+\alpha}{1-\beta}$; e is independent of y for $\theta \geq \frac{1+\alpha}{1-\beta}$): $\bar{e} = \frac{\alpha}{1+\alpha}$.

ii) $\frac{y}{2} < (1 + \alpha)^{-1} \leq y < (1 - \beta)^{-1}$: $e = 0$ for $\theta < (1 + \alpha)^{-1}$, $e = \frac{y}{\theta} - 1$ for $(1 + \alpha)^{-1} \leq \theta < y$, $e = 0$ for $y \leq \theta < (1 - \beta)^{-1}$, and $e = 1$ for $(1 - \beta)^{-1} \leq \theta$.

Average investment in education (over all $\theta < \frac{1+\alpha}{1-\beta}$): $\bar{e} = \frac{(1-\beta) \int_{(1+\alpha)^{-1}}^y (\frac{y}{\theta} - 1) d\theta}{1+\alpha} + \frac{\alpha}{1+\alpha} = \frac{(1-\beta)(y(\ln y - \ln(1+\alpha)^{-1}) + (1+\alpha)^{-1})}{1+\alpha} + \frac{\alpha}{1+\alpha}$ with $\frac{\partial \bar{e}}{\partial y} = \frac{1-\beta}{1+\alpha}(\ln y - \ln(1 + \alpha)^{-1}) > 0$ as $y > (1 + \alpha)^{-1}$.

iii.1) $\frac{y}{2} < (1 + \alpha)^{-1} < (1 - \beta)^{-1} \leq y$: $e = 0$ for $\theta < (1 + \alpha)^{-1}$, $e = \frac{y}{\theta} - 1$ for $(1 + \alpha)^{-1} \leq \theta < (1 - \beta)^{-1}$, and $e = 1$ for $(1 - \beta)^{-1} \leq \theta$. Average investment in education (over all $\theta < \frac{1+\alpha}{1-\beta}$): $\bar{e} = \frac{(1-\beta) \int_{(1+\alpha)^{-1}}^{(1-\beta)^{-1}} (\frac{y}{\theta} - 1) d\theta}{1+\alpha} + \frac{\alpha}{1+\alpha} = \frac{(1-\beta)(y(\ln(1-\beta)^{-1} - \ln(1+\alpha)^{-1}) - (1-\beta)^{-1} + (1+\alpha)^{-1})}{1+\alpha} + \frac{\alpha}{1+\alpha}$

with $\frac{\partial \bar{e}}{\partial y} = \frac{1-\beta}{1+\alpha}(\ln(1 - \beta)^{-1} - \ln(1 + \alpha)^{-1}) > 0$.

iii.2) $(1 + \alpha)^{-1} \leq \frac{y}{2} < y < (1 - \beta)^{-1}$: $e = 0$ for $\theta < (1 + \alpha)^{-1}$, $e = 1$ for $(1 + \alpha)^{-1} \leq \theta < \frac{y}{2}$, $e = \frac{y}{\theta} - 1$ for $\frac{y}{2} \leq \theta < y$, $e = 0$ for $y \leq \theta < (1 - \beta)^{-1}$, and $e = 1$ for $(1 - \beta)^{-1} \leq \theta$. Average investment in education (over all $\theta < \frac{1+\alpha}{1-\beta}$): $\bar{e} = \frac{(1-\beta)(y/2 - (1+\alpha)^{-1})}{1+\alpha} + \frac{(1-\beta) \int_{y/2}^y (\frac{y}{\theta} - 1) d\theta}{1+\alpha} + \frac{\alpha}{1+\alpha}$

$= \frac{(1-\beta)(y/2 - (1+\alpha)^{-1})}{1+\alpha} + \frac{(1-\beta)(y(\ln y - \ln(y/2)) - y/2)}{1+\alpha} + \frac{\alpha}{1+\alpha}$ with $\frac{\partial \bar{e}}{\partial y} = \frac{1-\beta}{1+\alpha}(\ln y - \ln(y/2)) > 0$.

iv) $(1 + \alpha)^{-1} \leq \frac{y}{2} < (1 - \beta)^{-1} \leq y$: $e = 0$ for $\theta < (1 + \alpha)^{-1}$, $e = 1$ for $(1 + \alpha)^{-1} \leq \theta < \frac{y}{2}$, $e = \frac{y}{\theta} - 1$ for $\frac{y}{2} \leq \theta < (1 - \beta)^{-1}$, and $e = 1$ for $\theta \geq (1 - \beta)^{-1}$.

Average investment in education (over all $\theta < \frac{1+\alpha}{1-\beta}$): $\bar{e} = \frac{(1-\beta)(y/2 - (1+\alpha)^{-1})}{1+\alpha} + \frac{(1-\beta) \int_{y/2}^{(1-\beta)^{-1}} (\frac{y}{\theta} - 1) d\theta}{1+\alpha} + \frac{\alpha}{1+\alpha} = \frac{(1-\beta)(y/2 - (1+\alpha)^{-1})}{1+\alpha} + \frac{(1-\beta)(y(\ln(1-\beta)^{-1} - \ln(y/2)) - 1/2) - (1-\beta)^{-1}}{1+\alpha} + \frac{\alpha}{1+\alpha}$

with $\frac{\partial \bar{e}}{\partial y} = \frac{1-\beta}{1+\alpha}(\ln(1 - \beta)^{-1} - \ln(y/2)) > 0$.

v) $(1 - \beta)^{-1} \leq \frac{y}{2}$: $e = 0$ for $\theta < (1 + \alpha)^{-1}$ and $e = 1$ for $\theta \geq (1 + \alpha)^{-1}$. Average investment in education (over all $\theta < \frac{1+\alpha}{1-\beta}$): $\bar{e} = 1 - \frac{1-\beta}{(1+\alpha)^2}$.

It is easy to show that \bar{e} is a continuous function of y . Together with i)-v) it is then proved that \bar{e} increases in y for $p \in (y, y + a]$.

b) For $p \in [y - a, y - 1]$ (for $a > 1$) and

i) $\frac{y}{2} < 1 \leq y < \frac{1+\alpha}{1-\beta}$: $e = 0$ for $\theta < 1$, $e = \frac{y}{\theta} - 1$ for $1 \leq \theta < y$, and $e = 0$ for $y \leq \theta < \frac{1+\alpha}{1-\beta}$. Average investment in education (over all $\theta < \frac{1+\alpha}{1-\beta}$; e is independent of y for $\theta \geq \frac{1+\alpha}{1-\beta}$): $\bar{e} = \frac{(1-\beta) \int_1^y (\frac{y}{\theta} - 1) d\theta}{1+\alpha} = \frac{(1-\beta)(y(\ln y - 1) + 1)}{1+\alpha}$ with $\frac{\partial \bar{e}}{\partial y} = \frac{(1-\beta) \ln y}{1+\alpha} \geq 0$.

ii.1) $\frac{y}{2} < 1 < \frac{1+\alpha}{1-\beta} \leq y$: $e = 0$ for $\theta < 1$ and $e = \frac{y}{\theta} - 1$ for $1 \leq \theta < \frac{1+\alpha}{1-\beta}$. Average investment in education (over all $\theta < \frac{1+\alpha}{1-\beta}$): $\bar{e} = \frac{(1-\beta) \int_1^{\frac{1+\alpha}{1-\beta}} (\frac{y}{\theta} - 1) d\theta}{1+\alpha} = \frac{(1-\beta)(y \ln \frac{1+\alpha}{1-\beta} - \frac{1+\alpha}{1-\beta} + 1)}{1+\alpha}$ with $\frac{\partial \bar{e}}{\partial y} = \frac{(1-\beta) \ln \frac{1+\alpha}{1-\beta}}{1+\alpha} > 0$.

ii.2) $1 \leq \frac{y}{2} < y < \frac{1+\alpha}{1-\beta}$: $e = 0$ for $\theta < 1$, $e = 1$ for $1 \leq \theta < \frac{y}{2}$, $e = \frac{y}{\theta} - 1$ for $\frac{y}{2} \leq \theta < y$, and $e = 0$ for $y \leq \theta < \frac{1+\alpha}{1-\beta}$. Average investment in education (over all $\theta < \frac{1+\alpha}{1-\beta}$): $\bar{e} = \frac{(1-\beta)(y/2 - 1)}{1+\alpha} + \frac{(1-\beta) \int_{y/2}^y (\frac{y}{\theta} - 1) d\theta}{1+\alpha} = \frac{(1-\beta)(y/2 - 1)}{1+\alpha} + \frac{(1-\beta)(y(\ln y - \ln(y/2)) - y/2)}{1+\alpha}$ with $\frac{\partial \bar{e}}{\partial y} = \frac{1-\beta}{1+\alpha} (\ln y - \ln(y/2)) > 0$.

iii) $1 \leq \frac{y}{2} < \frac{1+\alpha}{1-\beta} \leq y$: $e = 0$ for $\theta < 1$, $e = 1$ for $1 \leq \theta < \frac{y}{2}$, and $e = \frac{y}{\theta} - 1$ for $\frac{y}{2} \leq \theta < \frac{1+\alpha}{1-\beta}$. Average investment in education (over all $\theta < \frac{1+\alpha}{1-\beta}$):

$$\bar{e} = \frac{(1-\beta)(y/2 - 1)}{1+\alpha} + \frac{(1-\beta) \int_{y/2}^{\frac{1+\alpha}{1-\beta}} (\frac{y}{\theta} - 1) d\theta}{1+\alpha} = \frac{(1-\beta)(y/2 - 1)}{1+\alpha} + \frac{(1-\beta)(y(\ln \frac{1+\alpha}{1-\beta} - \ln(y/2)) - \frac{1+\alpha}{1-\beta} + y/2)}{1+\alpha}$$

with $\frac{\partial \bar{e}}{\partial y} = \frac{1-\beta}{1+\alpha} (\ln \frac{1+\alpha}{1-\beta} - \ln(y/2) + y - 1) > 0$.

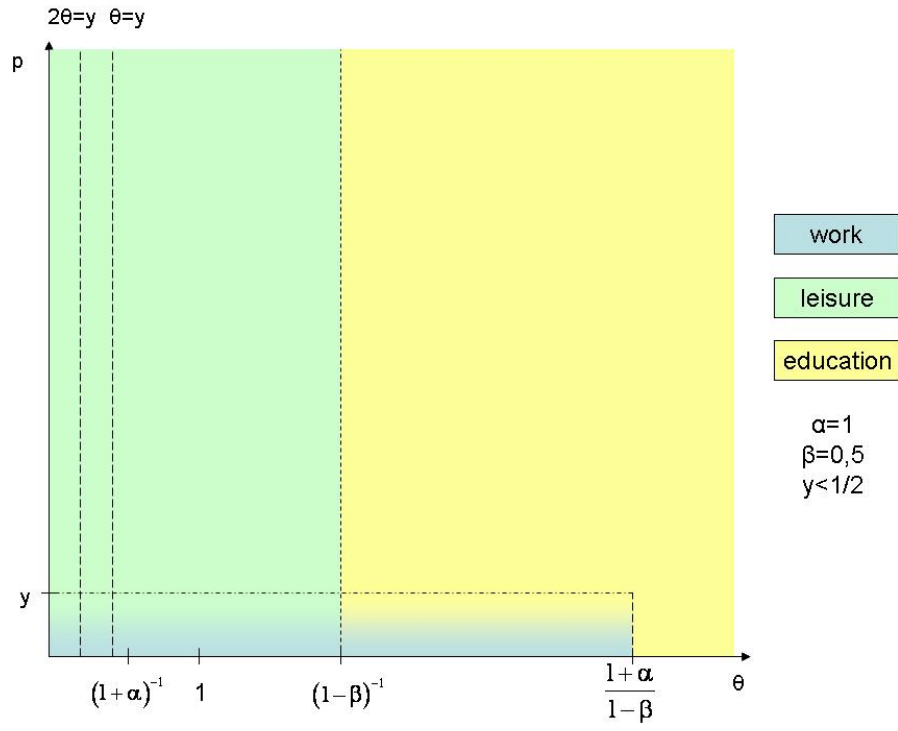
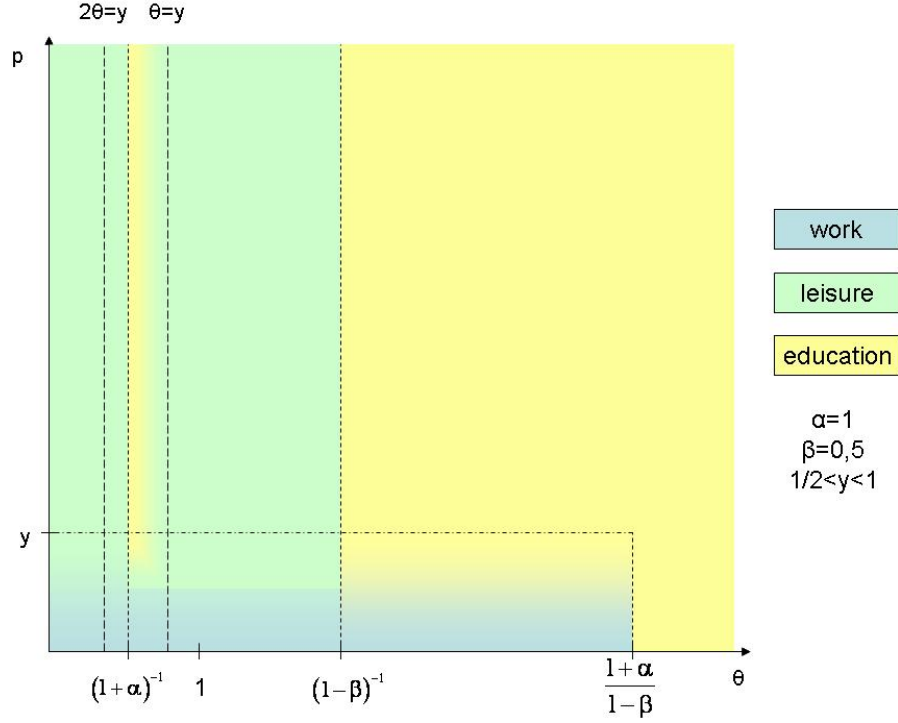
iv) $\frac{1+\alpha}{1-\beta} \leq \frac{y}{2}$: $e = 0$ for $\theta < 1$ and $e = 1$ for $1 \leq \theta < \frac{1+\alpha}{1-\beta}$. Average investment in education (over all $\theta < \frac{1+\alpha}{1-\beta}$): $\bar{e} = \frac{\alpha + \beta}{(1+\alpha)}$.

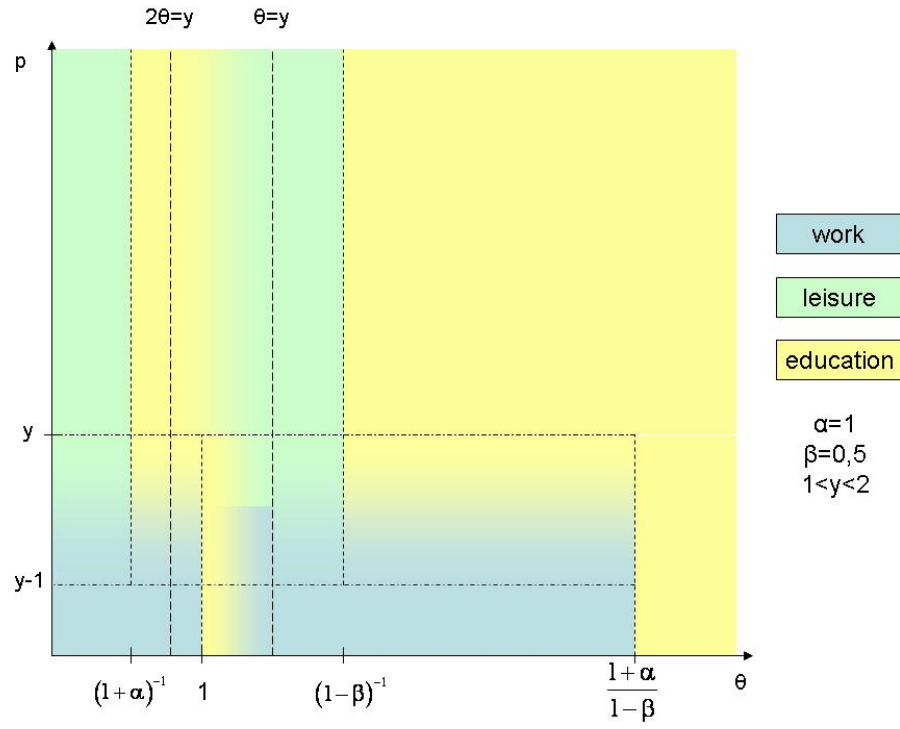
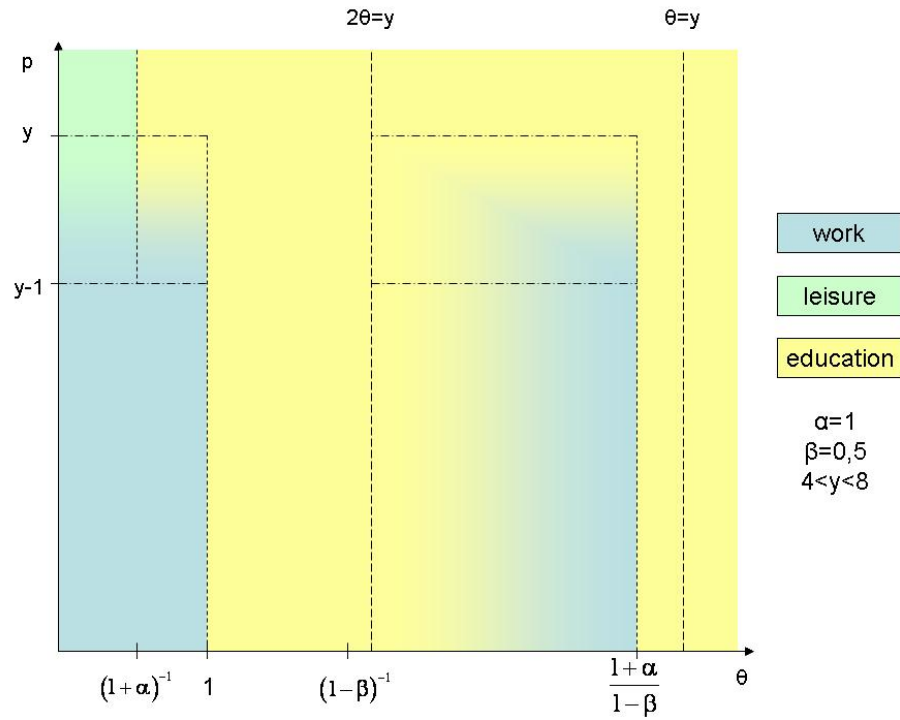
It is easy to show that \bar{e} is a continuous function of y . Together with i)-iv) it is then proved that \bar{e} increases in y for $p \in [y - a, y - 1]$ (for $a > 1$).

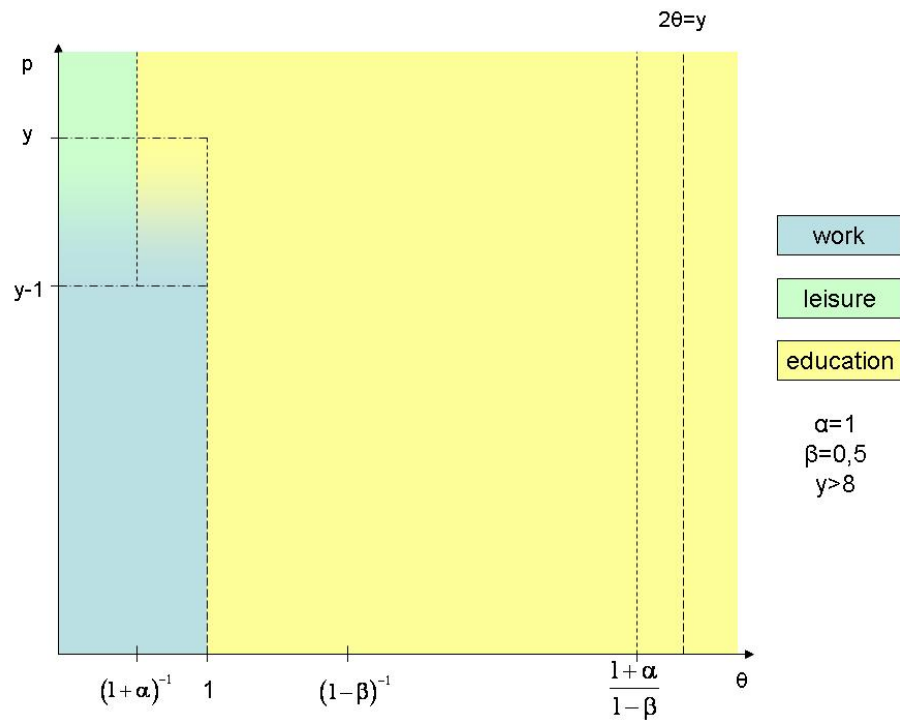
q.e.d.

3.8.2 Figures

The following figures illustrate the outcome of the education choice, if peer income y 's relative size in comparison to the inequity aversion parameters α and β is different from figure 3.1. We hold α and β constant and start with an extremely small peer income. Afterward we proceed with rising peer incomes. Figure 3.1 depicts a case in which y has a medium size and would be located between figures 3.4 and 3.5. As already mentioned the relative size of the peer's income in comparison to the parameters of inequity aversion is decisive, not their absolute values. Thus, the six figures represent (qualitatively) the vast majority of potential cases. But, there are still cases, in which outcomes look different. These are the cases in which both the $2\theta = y$ - and $\theta = y$ -lines lie in one of the five intervals of θ mentioned in section 3.2. But these are the less interesting cases and do not give new insights into the nature of the problem.

Figure 3.2: Education choice with an extremely low peer income y Figure 3.3: Education choice with a very low peer income y

Figure 3.4: Education choice with a low peer income y Figure 3.5: Education choice with a very large peer income y

Figure 3.6: Education choice with an extremely large peer income y

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Eidesstattliche Versicherung

Ich versichere hiermit eidesstattlich, dass ich die vorliegende Arbeit selbständig und ohne fremde Hilfe verfasst habe. Die aus fremden Quellen direkt oder indirekt übernommenen Gedanken sowie mir gegebenen Anregungen sind als solche kenntlich gemacht. Die Arbeit wurde bisher keiner anderen Prüfungsbehörde vorgelegt und auch noch nicht veröffentlicht.

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