

# Is Intra-Industrial Trade to Blame for Rising Inequality?

A dynamic model analyzing the effects different trade regimes have on the distribution of human capital and income.

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## Abstract

In recent years, the question if and how trade influences the structure of income inequality within countries has once again become of rising interest both to politicians and economists. As globalization moves on rapidly the question of which will be its future effects on the population in industrialized and developing countries becomes increasingly important. Empirical evidence seems to lead to the conclusion that rising openness is often associated by an increase in domestic income inequality. For example Savvides (1998) who uses the data provided by Deininger and Squire (1996) shows, that especially in the period of the eighties, when developing countries largely liberalized their trade, a positive relation between openness and income inequality was recognizable. These facts fully object Stolper-Samuelson's and Heckscher-Ohlin's predictions concerning labor-abundant countries which open themselves for trade. Conform to theory, one shall expect falling relative wages for the high-skilled labor force and rising ones for low-skilled workers. Thus in developing countries especially the poor should benefit from globalization. What is found points in the opposite direction. The model presented in our paper tries to solve this puzzle by showing that differences in the income effects of different trade regimes can play a crucial role in explaining rising income inequality. We show, that as a country increasingly turns to intra-industrial trade the equalization effect of inter-industrial trade on the distribution of income is substantially reduced if not reversed. We reach this result by nesting sector specific inter- and intra-industrial trade into a dynamic model of human capital formation, where individual abilities and parental influence play a major role in determining the prevailing level of inequality and inter-generational mobility. More precisely, we include a sector of diversified goods produced under monopolistic competition into a Specific Factor Model as it was described by Jones (1971), with high- and low-skilled labor as specific factors. The second sector remains entirely competitive and produces standardized goods. With individuals having a "love for variety" in goods consumed, we are able to show

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that an increase in variety results in rising relative product prices for diversified goods and thus causes wages of high-skilled workers to rise and those of low-skilled workers to fall. This change in factor prices is then used to determine the resulting change in the distribution of human capital and income, within a dynamic overlapping generations framework. The process of human capital accumulation used is based on individuals investing in their personal abilities to become high-skilled. It is shown that a rise in high-skilled wages causes rising inequality of individual opportunities. Furthermore the model is able to show that the inclusion of intra-industrial trade can lead to higher overall rates in income inequality. Yet, we predict this increase to be smaller for those countries which initially are relatively well endowed with high-skill labor. As a possible extension we point out, that our model can serve as a possible explanation not only for changes in inequality within, but also across countries.

**Keywords:** income, inequality, trade, growth

**JEL Classification:** D30, F10, I32, J24, J62

## Contents

1	Introduction . . . . .	2
2	The Model . . . . .	4
2.1	Production . . . . .	4
2.1.1	The Common Goods Sector . . . . .	4
2.1.2	The Diversified Goods Sector . . . . .	5
2.1.3	Relative Supply . . . . .	7
2.2	The Individual . . . . .	9
2.2.1	The Formation of Human Capital . . . . .	10
2.2.2	Utility and Budgetary Constraints . . . . .	14
3	The Effects of Openness on Distribution . . . . .	16
3.1	The Case of Inter-Industrial Trade . . . . .	16
3.2	Trade Between Similar Countries . . . . .	24
3.3	The Joint Effect of Inter- and Intra-Industrial Trade . . . . .	28
4	The Distribution of Income Across Countries . . . . .	29
5	Concluding Remarks . . . . .	31

## List of Figures

2.1	Capital Used in the Different Sectors . . . . .	7
2.2	Production Possibility Curve . . . . .	8
2.3	The Individual over Time . . . . .	10
2.4	Ability Related Investment in Human Capital . . . . .	11
2.5	The Parental Effect . . . . .	14
3.1	Trade Effects on Supply and Demand . . . . .	16
3.2	The Change in Capital Allocation . . . . .	17
3.3	Lorenz Curves . . . . .	20
3.4	Changes in Distribution . . . . .	21
3.5	Interindustrial Trade and Inequality . . . . .	24
3.6	The Effect of Inter-Industrial Trade on Relative Prices . . . . .	25
3.7	Intraindustrial Trade and Inequality . . . . .	27
3.8	The Effect of Trade on Prices . . . . .	29

## 1. Introduction

In the model presented below, we examine the joint effects of different trade regimes on the distribution of income within countries. The two trade regimes that are used in this model are the classical trade mechanism built on comparative advantages and the new trade theory. In the literature for each of these trade regimes there has been the claim that trade can foster economic welfare and leads to a narrowing of the income gap especially within developing countries. Among others it were Stolper and Samuelson (1941), Heckscher (1919) and Ohlin (1933), Krugman (1979,1981) and Helpman (1981) who provided important work on this subject<sup>1</sup>. Despite of these theoretical concepts, the influence of trade on distribution remains highly debated. The central reason for this are the changes in income inequality observed around the world (Atkinson 1997). Instead of the expected narrowing of the income gap the opposite seems to be observable. Savvides (1998) who uses the dataset of Deininger and Squire (1996) shows that especially in the period of the eighties, when developing countries largely liberalized their trade, a positive relation between openness and income inequality was recognizable. This fully objects Stolper-Samuelson's and Heckscher-Ohlin's predictions concerning labor-abundant countries which open themselves for trade. Conform to theory, one shall expect falling relative wages for the high-skilled labor force and rising ones for low-skilled workers. For the post-Nafta Mexico Harrison and Hanson (1999) report that wages of skilled workers have risen. Similar results can be found at Pissarides (1997). In a survey of studies which analyzed the development of wages mainly in Latin American countries, he finds that especially in high-skill and exporting industries one can track down such a wage raise. Beyer et al. (1999) find the puzzling result that Chile, which is relatively abundant in low-skill labor, experienced a rising wage gap caused by falling relative prices of low-skilled labor intensive goods.

The model presented in this paper tries to solve this puzzle by showing that differences in the income effects of different trade regimes can play a crucial role in explaining rising income inequality. We show, that as a country increasingly turns to intra-industrial trade the factor price equalization effect of inter-industrial trade on the distribution of income is substantially reduced if not reversed. The necessary integration of both types of trade into one single model is therefore a central part of our work. This is realized by the use of the Specific-Factor-Model as it was developed by Jones (1971). Two perfectly immobile specific factors, which we refer to as low- and high-skilled labor, are employed in different sectors of production. A third factor, capital, can move freely between both sectors. The

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<sup>1</sup>Krugman (1981) finds that if products are sufficiently differentiated or if countries are sufficiently similar both factors gain from trade. As a result of his model Helpman (1981) suggests that the dispersion of income is negatively correlated with the share of intra-industrial trade in the total trade of a country.

two sectors of our model produce goods traded either via inter- or intra-industrial trade. The advantage of this approach is that we reach an unambiguous result for the effect trade has on the income of both specific factors.

The way in which income inequality is modeled in this paper follows the tradition of Galor and Zeira (1993) who used inter-generational dynamics of human capital formation to describe the emergence of income inequality in their model. In their approach, capital market restrictions keeps the offspring of parents who do not leave large bequests from investing in their human capital. In our model we nest the sector specific inter- and intra-industrial trade model into an overlapping generation framework where individual investment in human capital is claimed to be dependent both on individual abilities and parental wealth<sup>2</sup>.

The parental wealth externality on an offspring's investment into its human capital is supposed to be nonmaterial and can be understood as experience that is gained by the fact that the individual is born to rich parents<sup>3</sup>. Thus individuals from a well-to-do parental background need to invest less in their skills, with the optimal behavior of the parental generation left unchanged. This creates persistent inequality in our society both in income and in opportunities. As trade in the two sectors of our model will alter the wage structure, we expect it to have a direct effect on the given income inequality.

The paper is outlined as follows: In the next section we develop the basic structure of the model outlined above. In the third section we will then examine the effects openness has both on individual income and the formation of human capital respectively. This is reached by subsequently analyzing first the effects of solely inter- or intra-industrial trade before finally turning to the joint effects of both forms of trade on inequality. In section four we extend the basic model by pointing out the implications it may have on the inequality of income across countries. The fifth and last section summarizes our findings and concludes.

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<sup>2</sup>In their paper on inequality and technological progress Galor and Tsiddon (1997) provide a model which also uses the individual ability for allocating workers to different industries. Similar results one can find in Chiu (1998) who shows that in a dynamic model with ability related returns to human capital investment, a greater initial income equality will rise aggregated human capital accumulated and lead to an improvement in all subsequent generations initial income distribution.

<sup>3</sup>A parental influence on an offspring's investment into human capital has been shown to exist among others by Dearden, Marchin and Reed (1996) who find on the basis of British data a lower intergenerational mobility for high skill offsprings. Still as pointed out by Rubinstein and Tsiddon (1998) there is evidence that the effect is not caused directly by parental income, but seems highly related to parental education. Our approach partially accounts for these results by assuming a non-financial parental transfer. Still, as these transfers eventually are dependent on parental *income* we fall short to include all of the evidence given by Rubinstein and Tsiddon.

## 2. The Model

### 2.1. Production

We describe the economy of two small countries, which we further refer to as *Home* and *Foreign*. The countries in our model are supposed to have two different factors of production: capital, which is assumed to be mobile across the different industrial sectors, and labor. By education, labor can acquire certain sector-specific skills<sup>4</sup> and divides into high-skill  $L_D$  and low-skill  $L_C$  labor. The educational process will be described in detail in the second subsection. For now it is sufficient to state, that such a division occurs. The given factors of production are used in two different sectors. As the model's primary objective is to examine the effects of both inter- and intraindustry trade on the distribution of human capital, we need an environment where goods are produced under the condition of perfect competition and where production follows the pattern of monopolistic competition. While sector one of our model incorporates the first, sector two will describe the latter.

#### 2.1.1. The Common Goods Sector

The first sector which we call the "Common Goods Sector"  $C$ , produces a simple common good, which we assume to be an aggregate of all possible common goods in our society. Examples for such goods might be food, clothing or goods like steel and basic artificial fibres. Firms do not possess market power and production is pursued with constant economies of scale. The factors that are needed for the production of the common goods are capital and low-skilled labor.

$$f_C(K, L_C) \tag{2.1}$$

The production function is supposed to have the following properties:

$$\frac{\partial f_C}{\partial K}, \frac{\partial f_C}{\partial L_C} > 0 \text{ and } \frac{\partial^2 f_C}{\partial^2 K}, \frac{\partial^2 f_C}{\partial^2 L_C} < 0; \forall K, L_C \tag{2.2}$$

$$\lim_{K, L_C \rightarrow 0} \frac{\partial f_C}{\partial K}, \frac{\partial f_C}{\partial L_C} = \infty \text{ and } \lim_{K, L_C \rightarrow \infty} \frac{\partial f_C}{\partial K}, \frac{\partial f_C}{\partial L_C} = 0 \tag{2.3}$$

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<sup>4</sup>The assumption, that all education is sector-specific is rather stylized. In more general terms it could be stated, that labor is supposed to enter each industry in the form of a product-specific vector made up by the differently skilled workers that are needed for production  $l_i(l_0; l_1; l_2; \dots; l_n)$ . Still, even in that case we can achieve the above result by additionally assuming that  $\frac{\partial f_i}{\partial l_j} \gg \frac{\partial f_k}{\partial l_j} \approx 0$  holds, i.e. that a worker is a great deal more productive in the industry that he is specific too.

For production in competitive markets it has to hold, that the sum of the marginal products produced times the amount of factors employed shall equal the total production:

$$f_C(K, L_C) = MPK_C K_C + MPL_C L_C \quad (2.4)$$

Production costs in this sector are supposed to be solely dependent on the rents paid to those two factors of production

$$C = w_C L_C + r_C K_C. \quad (2.5)$$

Given that in this sector the price equals the marginal costs it follows from minimizing production costs that:

$$\frac{w_C}{MPL_C} = \frac{r_C}{MPK_C} = p_C \quad (2.6)$$

$$r_C = p_C MPK_C \quad (2.7)$$

$$w_C = p_C MPL_C \quad (2.8)$$

Thus the sum of the factor product evaluated at the product price  $p_C$  exactly equals the wage sum.

$$p_C f_C(K, L_C) = w_C L_C + r_C K_C \quad (2.9)$$

### 2.1.2. The Diversified Goods Sector

The second sector produces diversified goods  $D$ , such as cars, machinery, or sophisticated consumption goods. As an important contrast to the first sector, the goods in this sector can be produced in such a diversity that firms do not compete against each other. As a result, each product in sector two is produced by a single firm. We assume a possible production range of  $N$  different products, of which  $n$  are actually produced. The factor inputs that are required for the production of diversified goods are capital and skilled labor.

$$f_{iD}(K, L_D) \quad (2.10)$$

Firms face fixed costs  $C$  of production and thus do produce with rising economies of scale<sup>5</sup>. We model costs in a way as if they "eat up" a part of the production. Since diversified goods are in many cases quality goods, costs may represent the amount of production which does not fulfill the required quality standard. Another interpretation might be that firms themselves constantly have to evaluate the skill of their employees. This then happens by a way of excess production which

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<sup>5</sup>As shown by Duc (1996) scale economies and diversity of preferences are important sources of intra-industrial trade, not only for industrialized but also for developing countries.

can't be sold on the market. As we will explain to a larger extent in chapter four, we can see these costs also as a tax on skill intensive products.

$$f_{iD}(K, L_D) = MPL_{iD}L_{iD} + MPK_{iD}K_{iD} - C \quad (2.11)$$

To evade the problem of monopoly rents, we follow Krugman (1981) and assume monopolistic competition. The fear of potential rivals entering one industry erodes monopoly rents and causes total revenue to equal the total costs of production:

$$p_{iD}f_{iD}(K, L_D) = w_{iD}L_{iD} + r_{iD}K_{iD} \quad (2.12)$$

Besides the conditions on standard neoclassical production functions that we already stated for sector one above, we additionally assume the production function in the diversified sector to be the same for all industries.

$$f_{iD}(K, L_D) = f_{jD}(K, L_D) \quad (2.13)$$

Thus we can easily aggregate output and costs of the second sector over the  $n$  different products.

$$f_D(K, L_D) = MPL_{iD}L_D + MPK_{iD}K_D - nC \quad (2.14)$$

$$p_{iD}f_D(K, L_D) = w_{iD}L_D + r_{iD}K_D, \quad (2.15)$$

with

$$\begin{aligned} p_{iD} &= p_{jD} \equiv p_D \\ MPL_{iD} &= MPL_{jD} \equiv MPL_D \\ MPK_{iD} &= MPK_{jD} \equiv MPK_D. \end{aligned} \quad (2.16)$$

Maximizing the output with respect to capital and labor under the no-profit restriction, we get the following result for the factor costs:

$$r_D = p_D MPK_D \left( \frac{f_D(K, L_D)}{f_D(K, L_D) + nC} \right) \quad (2.17)$$

$$w_D = p_D MPL_D \left( \frac{f_D(K, L_D)}{f_D(K, L_D) + nC} \right) \quad (2.18)$$

As  $f_D(K, L_D)$  is smaller than  $f_D(K, L_D) + nC$  the term  $\frac{f_D(K, L_D)}{f_D(K, L_D) + nC}$  lies in-between zero and one. Thus rents and wages in the diversified sector will be smaller than their marginal value product.

### 2.1.3. Relative Supply

As labor is sector specific, for an integration of both sectors we examine the common factor  $K$ . Beyond its use as a factor of production, capital is necessary to generate the specific skills from the existing personal abilities. Thus, the net demand for capital due to education has to be added to the capital needed for production. Apart from this we suppose net private and public borrowing to be zero. We therefore can write the total capital in our home country as:

$$K_H = K_C + \sum_{i=0}^n K_i + [I_t - (1 + r) I_{t-1}] \quad (2.19)$$

The proportion of capital used in each sector is determined by its marginal value product. For capital will move to the sector where it receives the higher payment. This condition is illustrated in figure one.

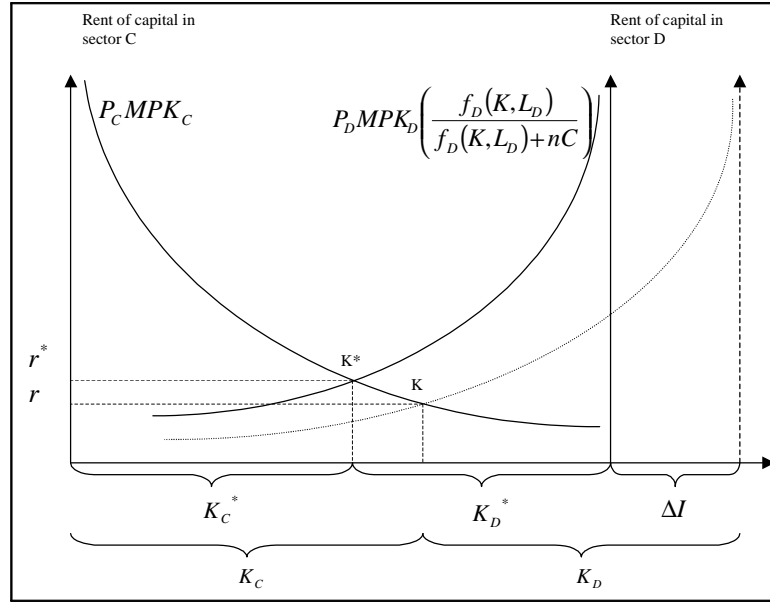


Figure 2.1: Capital Used in the Different Sectors

It is to be seen, that the net investment in human capital will potentially limit the amount of capital available for production and thus will increase the capital costs  $r$ . Yet, throughout this paper we shall make the additional assumption that this rise is rather small i.e. that:  $\frac{\partial r}{\partial \Delta I} \approx 0$ . It might be worth noting that although the total sum of capital might change, the proportion of capital invested in the two different sectors remains the same. In equilibrium at point  $(K^*, r_c^*)$  the rents earned by capital in either sector are the same. Capital has no incentive

to move from one sector to another. The corresponding point at the production possibility frontier can formally be derived by setting  $r_C = r_D$  which yields:

$$-\frac{MPK_C}{MPK_D} = -\frac{p_{iD}}{p_C} \left( \frac{f_D(K, L_D)}{f_D(K, L_D) + nC} \right) \quad (2.20)$$

The marginal product of capital in the production of the two goods hence can be shown to equal in equilibrium one over the relation of the corresponding prices times the relation of production without costs over production with costs. This means, that due to the introduction of costs, the slope of the tangent on the production possibility frontier which determines the optimum point of production becomes flatter. Consequently, the relation of goods produced in equilibrium changes. The introduction of costs leads to a higher output of the common goods and a lower one of the diversified goods. These facts are described by figure two. Given fixed costs in industry  $D$  the equilibrium production realizes

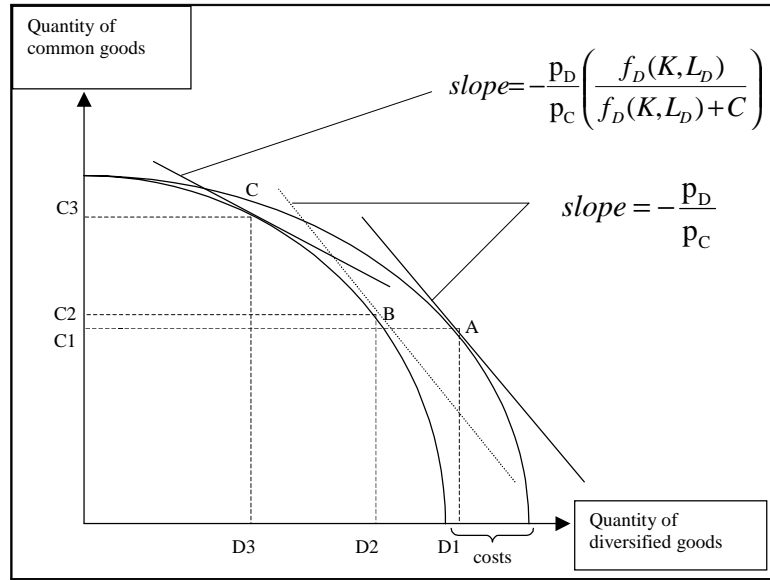


Figure 2.2: Production Possibility Curve

at point  $(C3, D3)$ . Without costs, but given a set of inputs that leave us to the same production possibility frontier, production has to be  $(C2, D2)$ .  $(C1, D1)$  represents the point of production without costs. Though we prefer to keep them unchanged in this framework, we find it important to state, that an endogenous determination of the level of fixed costs in different industries may well be used to reach an endogenous distribution of industries over the given sectors.

After having derived relative supply according to the above mentioned procedure, we will now turn to examine the behavior of the individual which will

eventually provide us with a functional form of relative demand in our society.

## 2.2. The Individual

The importance of individual human capital for a country's development has often been stressed. Loury (1981), for example, shows that if parents investment in their children's human capital is constrained, there will be an inefficient allocation of resources. This idea has since been applied in different ways. Durlauf (1992) and Benabou (1994) describe the formation of communities in society and conclude that human capital accumulation can thus lead to inequality. Galor and Zeira (1993), Wickström, and Banerjee and Newman (1993) make use of capital market imperfections to reach similar results, while Galor and Tsiddon (1994) use the impact technological progress has on human capital accumulation to generate a persistent inequality of income.

On the empirical side Bourguignon (1990) provides evidence, that trade distortions and the endowment in secondary schooling are major determinants of differences in income inequality. Similar results were put forward by Benabou (1996). Still, these models mostly cover only inequality in earnings. Yet, with our paper we attempt to go beyond that and examine the effect inequality in opportunities has on the formation of human capital. Interesting research on that subject has lately been provided by Owen and Weil (1997) who showed that an increasing inter-generational mobility can have positive effects on a country's growth.

The behavior of individuals in our model is described within a dynamic overlapping generations framework. Each individual is supposed to have a lifespan of two periods. At the beginning of the first period, individuals are born and acquire their education. We assume that education is not time consuming at all, which poses a contrast to what is observed in reality. Thus, individuals merely need to invest the required capital to improve their abilities. The amount of investment needed to become skilled we assume to vary due to individual abilities and parental wealth. In the first period the individual uses its education to work and consume the goods available. At the beginning of the second period to each individual a child is born. For the rest of their lives (i.e. this period) individuals consume the goods produced, thus spending the money they have saved in the first period and die. The detailed setup of individual life is illustrated in the next figure.

As can be seen this leaves the individual with two decision problems. First, it has to decide whether to invest in its abilities or not, and second, it will optimize its consumption decision over the given periods. Both decision problems will be solved separately in the next two subsections. We then use the results to determine the relative demand function for our model.

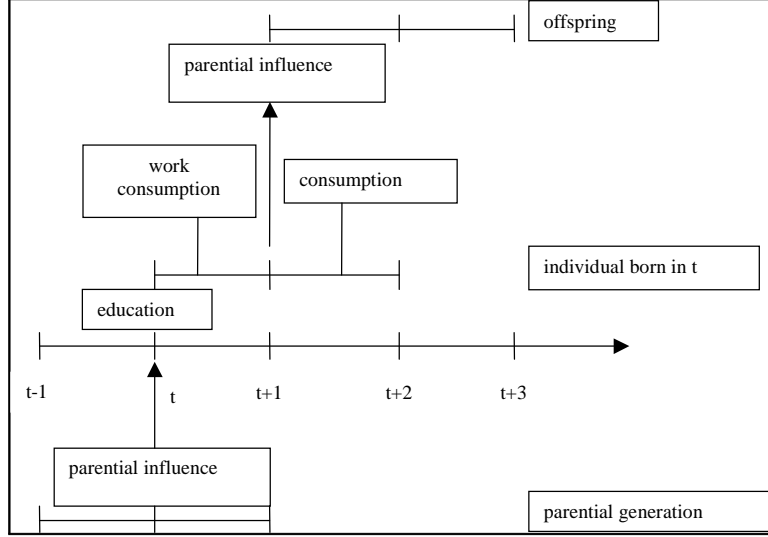


Figure 2.3: The Individual over Time

### 2.2.1. The Formation of Human Capital

Up to this point, we assumed the composition of the labor force to be fixed. While this is true for each period of our model, due to the immobility of labor, we will have to allow for a changing composition of the labor force, as we turn to the behavior of generations over time. If they find it expedient, individuals can invest in their skills and become high-skilled. Besides taking decisions on the equilibrium amount of goods consumed, individuals also have to decide on whether they should invest in their skills or not. We suppose, that this decision is entirely determined by the wages-rates in the two sectors and the amount of investment that has to be undertaken by the individual. Since we assume that there is no intrinsic motivation to become educated, for an individual to invest in its skills, the following condition needs to apply:

$$w_D - I \geq w_C \quad (2.21)$$

The Individuals in this framework are supposed to be born with different abilities  $a_t^i$ . We assume these abilities to be uniformly distributed over the support  $[0, 1]$ <sup>6</sup>

$$a_t^i \sim U[0, 1]. \quad (2.22)$$

<sup>6</sup>For a similar approach we refer to Galor and Tsiddon (1997) who also link the eventual size of high- and low-skilled labor forces to investments undertaken in individual abilities

Furthermore, we believe that the investment needed to become a high-skilled worker is decreasing in individual ability

$$I = I(a), \quad (2.23)$$

with

$$\frac{\partial I}{\partial a} < 0; \frac{\partial^2 I}{\partial^2 a} > 0. \quad (2.24)$$

So with increasing ability the necessary investment will become smaller, yet at a decreasing rate. Given these assumptions, we observe that in equilibrium our population will be divided into individuals with a high average ability who work in the diversified sector and earn the wage  $w_D$  and those with lower abilities who work in the common goods sector and earn the wage  $w_C$ . In this way individuals

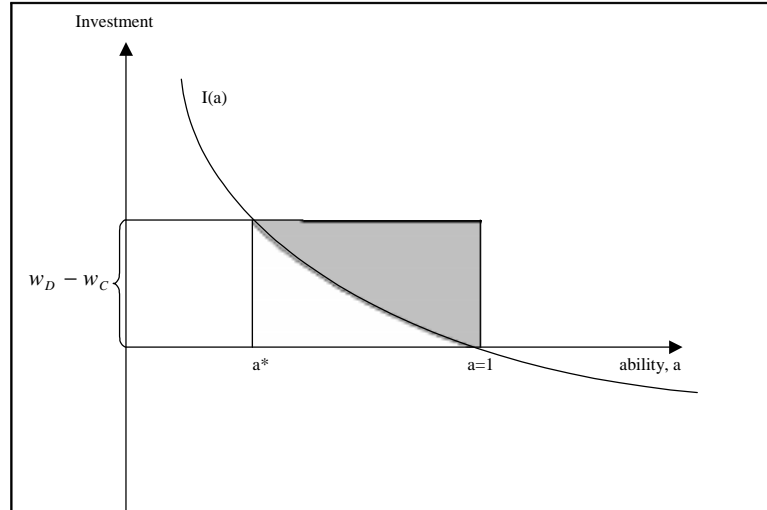


Figure 2.4: Ability Related Investment in Human Capital

do have an incentive to invest into their human capital as long as the investment they need to undertake in their human capital to become skilled is smaller than the experienced wage gap  $w_D - w_C$ . As can be seen in the diagram, we additionally assumed, that as ability rises to its maximum value  $\lim a \rightarrow 1$  it follows that the necessary investment approaches zero.  $I(a) \rightarrow 0$ . That means, that the most clever individual in our society has no investment costs to become skilled<sup>7</sup>. The worker with ability  $a^*$  is indifferent to qualifying for the high-skilled-sector or remaining unskilled.

<sup>7</sup>It can be seen that even if the most clever individual does have to invest any positive amount, all our findings do hold. The assumption is purely introduced to make results more viable in this and the following pictures.

Besides relative wages, the question of how the working population will divide into those two sectors is essential to determine the distribution of income. To see this, we have to examine up- and downward mobility of workers over time. Given that the initial population  $L$  is determined by

$$L^t = L_C^t + L_D^t = 1 \quad (2.25)$$

with

$$L_D^t = \sum_{i=1}^n l_i. \quad (2.26)$$

$L_D^{t+1}$  will depend on the following factors: first the portion of offspring to high-skill workers who decide to invest in their skills and become high-skilled themselves and second on the amount of low-skill offspring who decide that it is more advantageous for them to invest in their skills and become part of the high-skill labor force, than to work like their parent did. Likewise the size of the common goods sector labor force is determined. Formalizing this yields:

$$\begin{aligned} L_C^{t-1} \int_0^{a_C^t} D(a_C^t) da + (1 - L_C^{t-1}) \int_0^{a_D^t} D(a_D^t) da &= L_C^t \\ (1 - L_D^{t-1}) \int_{a_C^t}^1 D(a_C^t) da + L_D^{t-1} \int_{a_D^t}^1 D(a_D^t) da &= L_D^t \end{aligned} \quad (2.27)$$

With  $D(a)$  the distribution of abilities. Considering the assumptions we have taken with respect to this distribution, we can rewrite the above equations in a more convenient way:

$$\begin{aligned} L_C^{t+1} &= a_C^t L_C^t + a_D^t (1 - L_C^t) \\ L_D^{t+1} &= (1 - a_D^t) L_D^t + (1 - a_C^t) (1 - L_D^t) \end{aligned} \quad (2.28)$$

Rearranging yields that for the steady-state in which  $L_{D,C}^{t-1}$  equals  $L_{D,C}^t$  it has to hold that:

$$L_C^{t+1} = \frac{(a_D^t)}{1 - (a_C^t - a_D^t)} \quad (2.29)$$

$$L_D^{t+1} = \frac{(1 - a_C^t)}{1 - (a_C^t - a_D^t)}. \quad (2.30)$$

One can easily see that the upper equations reduce to  $L_C^{t+1} = a^t$  and  $L_D^{t+1} = 1 - a^t$  given that opportunities of newborns are the same in both sectors and hence  $a_D^t = a_C^t \equiv a^t$ . In the analysis of the effects of trade, this case will serve as an important benchmark.

We shall now introduce inter-generational dependencies. As empirical evidence suggests a strong parental impact on the formation of human capital

(Becker 1986), we find it reasonable to adapt our model in a way to represent this stylized fact. We will use this effect in our model to describe rising or diminishing inequality in opportunities, which we believe is as important as inequality in factor income. Furthermore, we will use the parental effect to show why we observe the formation of different clusters of inequality across countries (Quah (1997)).

So far we assumed, that the investment undertaken by an individual to become high-skilled is solely dependent on its abilities  $I^t = I(a^t)$ . To introduce a parental effect we shall now assume that this investment decreases in parental wealth

$$I^t = I(a^t) - z(a^t, w^{t-1}), \quad (2.31)$$

with

$$\frac{\partial z}{\partial a^t} < 0; \frac{\partial^2 z}{\partial^2 a^t} > 0 \quad (2.32)$$

and

$$\frac{\partial z}{\partial w^{t-1}} > 0; \frac{\partial^2 z}{\partial^2 w^{t-1}} < 0. \quad (2.33)$$

Thus a higher parental income will lower the investment the offspring has to undertake. Still, it seems reasonable to assume that this effect diminishes as the ability of an offspring approaches zero. The form and effect of  $z(a^t, w^{t-1})$  can also be seen in the below figure. In the graphic we have included different investment curves:  $I(a)$  represents our initial model where children born to either parent have the same opportunities. The  $I(a) - z(a^t, w_D^{t-1})$  curve on the other hand mirrors the better possibilities, that children of richer parents might experience. As one can see in the absence of parental externalities, a fraction  $1 - a_1$  of both the high-skilled and low-skilled workers will invest in their skills. Given the parental effect  $z$ , the share of high-skilled offspring investing in their skills will rise to  $1 - a_2$ . Thus, their relative share in total high-skill wage surplus rises from  $\frac{A}{A}$  to  $\frac{A+B}{A}$ . Hence the parental effect is responsible for both inequality in opportunities - a higher share of rich offspring will qualify - and inequality in income. In addition to its effect on distribution, the parental externality also has an effect on production. This fact can also be derived from the above diagram. As we see, the parental effect increases the share of offspring of high-skilled workers who will invest into their skills and become high-skilled workers themselves. Consequently, the total number of qualified workers in society will rise while the number of low-skilled workers will fall. This effect is only partially offset by the following fall in high-skilled workers marginal product and the rise in low-skilled marginal product respectively. There will be a new equilibrium point of production with lower high-skill wages and higher low-skilled wages, falling relative prices  $\frac{P_D}{P_C}$  and falling relative production of diversified goods  $\frac{x_D}{x_C}$ .

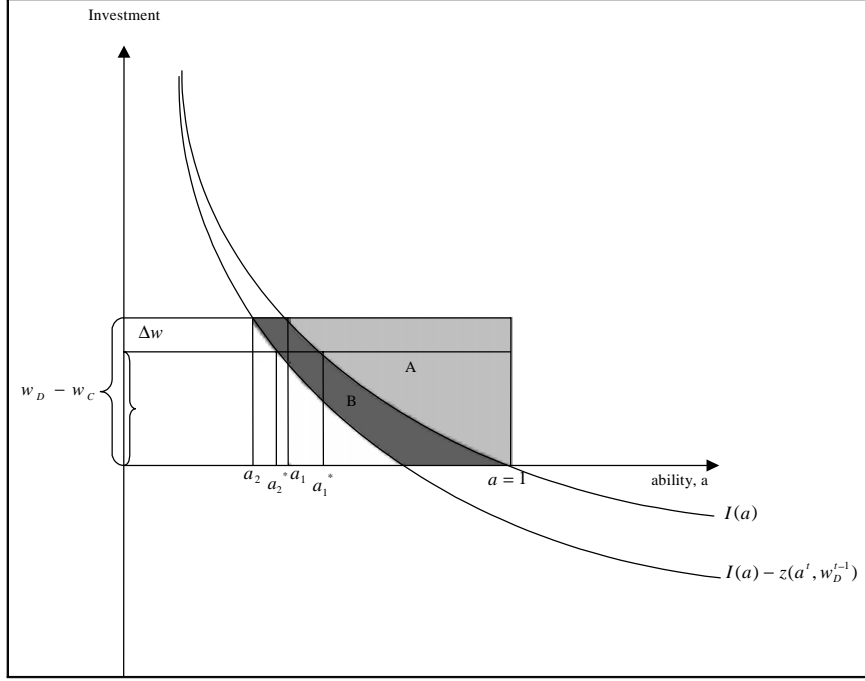


Figure 2.5: The Parental Effect

### 2.2.2. Utility and Budgetary Constraints

After describing the decision problem individuals face with respect to their personal choice of qualification, we now analyze the optimization problem individuals face when planning their consumption. Individuals are assumed to have utility functions  $U_{C,D}^t$  of the following form:

$$U_{C,D}^t = v_C^t(c_C) + v_D^t(c_i) + \frac{v_C^t(c_C) + v_D^t(c_i)}{(1+r)} \quad (2.34)$$

Individuals presumably have a preference for the amount and variety of diversified goods consumed. In this we follow the work of Dixit and Stiglitz (1977).

$$v_D^t = \left[ \sum_{i=1}^{n_t} c_i^\theta \right]^{\frac{1}{\theta}} \quad (2.35)$$

With  $0 < \theta \leq 1$  as a measure for the intensity of such a love for variety. The assumption of constant elasticity of substitution will later help us to simplify the aggregated demand function.

In our society people are confronted with the following budget constraint:

$$p_C c_C + \sum_{i=1}^{n_t} p_i c_i + \frac{p_C c_C + \sum_{i=1}^{n_{t+1}} p_i c_i}{(1+r)} = w_{C,D}^t - I(a^t, w^{t-1})^t \quad (2.36)$$

Thus, the total value of goods consumed has to equal the personal income minus the money spent on education. Maximization of utility under the budget constraint with respect to  $c_j$  and  $c_k$  leads us to the preliminary result:

$$\frac{1}{\theta} \left[ \sum_{i=1}^n v(c_i)^\theta \right]^{\frac{1}{\theta}} \theta v(c_i)^{\theta-1} \frac{\partial v(c_i)}{\partial c_j} = \lambda p_j \quad (2.37)$$

$$\frac{1}{\theta} \left[ \sum_{i=1}^n v(c_i)^\theta \right]^{\frac{1}{\theta}} \theta v(c_i)^{\theta-1} \frac{\partial v(c_i)}{\partial c_k} = \lambda p_k \quad (2.38)$$

Given  $p_k = p_j$  with  $v(c_i)$  concave,

$$v(c_j)^{\theta-1} \frac{\partial v(c_j)}{\partial c_j} = v(c_k)^{\theta-1} \frac{\partial v(c_k)}{\partial c_k} \quad (2.39)$$

can only be fulfilled if

$$c_j = c_k. \quad (2.40)$$

We shall use this information to simplify both utility function and budget constraint, so that the following Lagrangian maximizer applies:

$$\begin{aligned} \Phi = & v_C^t(c_C) + n^{\frac{1}{\theta}} v_D^t(c_D) + \frac{v_C^t(c_C) + n^{\frac{1}{\theta}} v_D^t(c_D)}{(1+r)} \\ & - \lambda \left( p_C c_C + p_D n c_D + \frac{p_C c_C + p_D n c_D}{(1+r)} - w_{i,h}^t + I^t(a, w^{t-1}) \right) \end{aligned} \quad (2.41)$$

Deriving the upper equation with respect to the level of consumption of common and diversified goods we get:

$$\frac{p_D}{p_C} = \frac{\frac{\partial v_D}{\partial c_D}}{\frac{\partial v_C}{\partial c_C}} n^{\frac{1-\theta}{\theta}} \quad (2.42)$$

Thus the relative marginal utility in the consumption of diversified goods times an index of the number of goods available equals the relative prices individuals are willing to pay. This means that individuals will generally be prepared to pay a higher price if the variety of goods increases.

### 3. The Effects of Openness on Distribution

In this subsection of the model we will examine the effects of openness on the distribution of income. First, we will concentrate on exclusively inter-industrial trade. We then turn to pure intra-industrial trade. In the third subsection we shall examine the consequences of both sorts of trade combined.

#### 3.1. The Case of Inter-Industrial Trade

In this section we establish the following significant benchmark case: in the diversified sector the number of goods produced will be limited to  $N = 1$ , costs  $C$  will be zero and the love for variety of individuals will also diminish as  $\theta$  equals one. In this case, production and consumption of goods produced in the diversified sector will be of the same type as is the case with common goods. Thus, with respect to openness we observe only inter-industrial trade which is determined by comparative advantage. As countries seek access to trade they will experience an equalization of relative product prices  $P_D$  and  $P_C$ , due to Stolper-Samuelson effects. At this point, we shall only examine the case where *Home* and *Foreign*

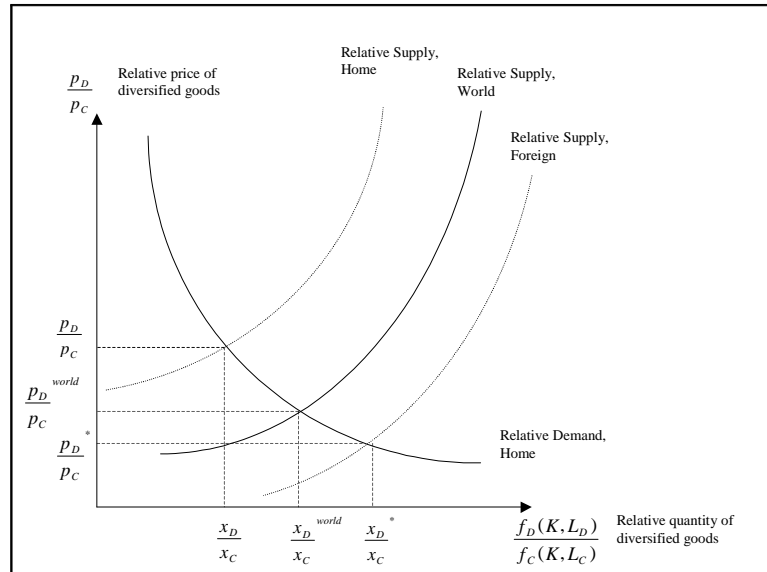


Figure 3.1: Trade Effects on Supply and Demand

have different, relative product prices. As for now we will assume that *Home* has a higher relative price  $\frac{P_D}{P_C}$  than *Foreign*. Prices in *Foreign* will be denoted by  $P_D^*$  and  $P_C^*$ . As the relative price of products in the diversified industries will fall, the amount of capital invested in the common sector will rise. For that, we

will again turn to the graphic that presents the use of capital by the different industries in our country.

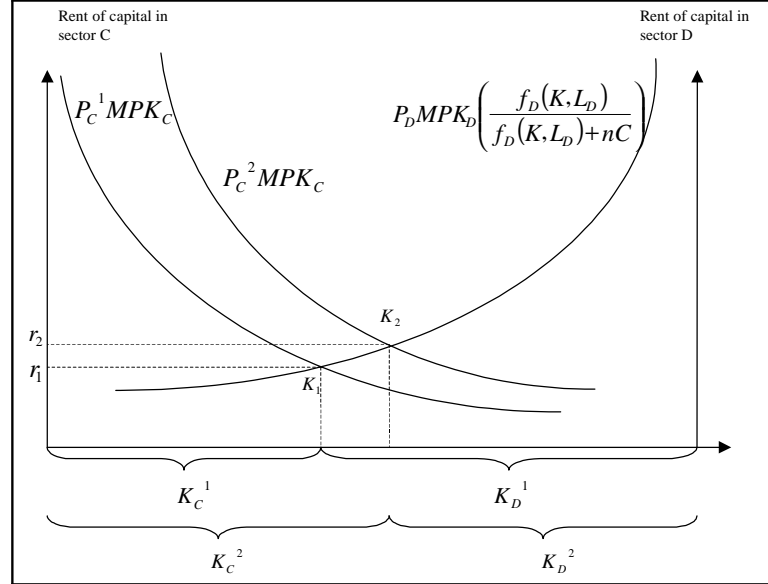


Figure 3.2: The Change in Capital Allocation

As can be seen from the diagram, a fall in  $\frac{P_D}{P_C}$  will cause the amount of capital invested in the common goods sector to rise, while the share invested in the diversified sector will fall. At this point it shall be stressed, that even if both prices, the ones in the common- and the once in the diversified sector fall, this is true.

As the use of capital in the common sector rises, its marginal product  $MPK_C$  will fall. Given the condition

$$P_C = P_C MPL_C + P_C MPK_C \quad (3.1)$$

we know, that as a result the marginal product of labor has to rise. As we mentioned in the first section of our model, rents in the common sector are the product price times the factor's marginal product. Thus from

$$\begin{aligned} MPL_C &= \frac{w_C}{P_C} \\ MPK_C &= \frac{r}{P_C} \end{aligned} \quad (3.2)$$

follows that  $\frac{w_C}{P_C}$  has to rise and  $\frac{r}{P_C}$  has to fall. For this to happen, the change in wages in the common sector has to be greater than the price change, while

changes in the return to capital are outweighed.

$$\dot{w}_C > \dot{P}_C > \dot{r} \quad (3.3)$$

Using the same set of arguments, we claim that the marginal product of labor in the diversified sector has to fall while the marginal product of capital rises

$$\begin{aligned} MPL_D &= \frac{w_D}{P_D} \downarrow \\ MPK_D &= \frac{r}{P_D} \uparrow \end{aligned} \quad (3.4)$$

and consequently

$$\dot{r} > \dot{P}_D > \dot{w}_D \quad (3.5)$$

will hold. We can conclude that the employees' real income in the common goods sector rises, whereas employees in the diversified industry will receive a lower real income.<sup>8</sup>

$$\dot{w}_C > \dot{P}_C > \dot{r} > \dot{P}_D > \dot{w}_D \quad (3.6)$$

For the rest of this paper we will, whenever stating a change in wages, refer to real wages. Next we are going to explore the distributional effects trade induced wage changes will have.

For that we need to determine what effect an exogenous change in relative wages on the equilibrium distribution of workers to the two sectors in question. To do so, we need to derive the total differential of the equilibrium share of low-skilled workers

$$L_C^{t+1}(a_D^t, a_C^t) = \frac{(a_D^t(w_C, w_D))}{1 - (a_C^t(w_C, w_D) - a_D^t(w_C, w_D))}, \quad (3.7)$$

which is the sum of the two total partial derivatives of that function with respect to a change in both high- and low-skilled wages

$$dL_C^{t+1} = \frac{\partial L_C^{t+1}}{\partial w_D} dw_D + \frac{\partial L_C^{t+1}}{\partial w_C} dw_C \quad (3.8)$$

With:

$$\frac{\partial L_C^{t+1}}{\partial w_D} = \frac{\partial L_C^{t+1}}{\partial a_D^t} \frac{\partial a_D^t}{\partial w_D} + \frac{\partial L_C^{t+1}}{\partial a_C^t} \frac{\partial a_C^t}{\partial w_D} \quad (3.9)$$

and:

$$\frac{\partial L_C^{t+1}}{\partial w_C} = \frac{\partial L_C^{t+1}}{\partial a_D^t} \frac{\partial a_D^t}{\partial w_C} + \frac{\partial L_C^{t+1}}{\partial a_C^t} \frac{\partial a_C^t}{\partial w_C}. \quad (3.10)$$

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<sup>8</sup>For a more general treatment of the effects a change in relative prices can have on wages in the specific sectors we refer to the original model of Jones (1971)

As

$$\frac{\partial L_C^{t+1}}{\partial a_D^t} = \frac{1 - a_C^t}{(1 - a_C^t + a_D^t)^2} \quad (3.11)$$

and

$$\frac{\partial L_C^{t+1}}{\partial a_C^t} = \frac{a_D^t}{(1 - a_C^t + a_D^t)^2} \quad (3.12)$$

we can also write:

$$dL_C^{t+1} = \frac{1 - a_C^t}{(1 - a_C^t + a_D^t)^2} \left[ \frac{\partial a_D^t}{\partial w_C} dw_C + \frac{\partial a_D^t}{\partial w_D} dw_D \right] + \frac{a_D^t}{(1 - a_C^t + a_D^t)^2} \left[ \frac{\partial a_C^t}{\partial w_C} dw_C + \frac{\partial a_C^t}{\partial w_D} dw_D \right]. \quad (3.13)$$

In first step we will assume that there is no parental effect  $z(a^t, w^{t-1}) = 0$ . We showed graphically that in this case  $a_D^t = a_C^t$ . As one can see this largely simplifies the above equation:

$$dL_C^{t+1} = \left[ \frac{\partial a_C^t}{\partial w_D} dw_D + \frac{\partial a_C^t}{\partial w_C} dw_C \right] \quad (3.14)$$

Since we also know that  $\frac{\partial a_C^t}{\partial w_D} > 0$  and  $\frac{\partial a_C^t}{\partial w_C} < 0$ , together with the results from inter-industrial trade  $dw_D < 0$  and  $dw_C > 0$  it has to follow that:

$$dL_C^{t+1} = \left[ \overbrace{\frac{\partial a_C^t}{\partial w_D} dw_D + \frac{\partial a_C^t}{\partial w_C} dw_C}^{\oplus} \right] > 0 \quad (3.15)$$

Given  $L_C^{t+1} + L_D^{t+1} = L$  it also follows that  $dL_D^{t+1} < 0$ . With respect to inequality in *Home*, we can hence state that both high-skill wages and high-skill share in the total work force fall, whereas low-skill wages and low-skill share in the work force rise. The given disparity in total factor income  $\frac{L_D^{t+1} w_D^{t+1}}{L_C^{t+1} w_C^{t+1}}$  will therefore decrease. As a second inequality measure, we shall use the *Gini* coefficient. As the graph shows, the *Gini* coefficient measures the difference between equal per head income, as illustrated by the triangular area below the 45 degree angle, and the actual wage structure which is described by the area below the Lorenz-Curve. In our model, as we have only two different wages, the Lorenz-Curve constitutes a line connecting the origin with point  $L_C w_C^1$ , which has the slope  $w_C$ , and a line from  $L_C w_C^1$  to  $[1, 1]$  with the slope  $w_D$ . Since the *Gini* coefficient is defined to be one minus twice the area below the Lorenz-Curve we can show that in our case this equals:

$$Gini = \frac{w_D L_D L_C - w_C L_C L_D}{w_D L_D + w_C L_C}. \quad (3.16)$$

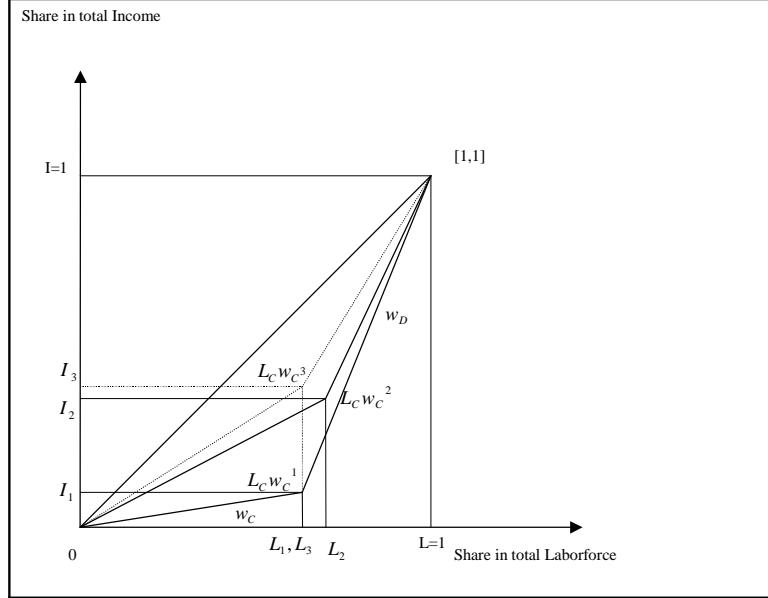


Figure 3.3: Lorenz Curves

Given the known behavior of  $w_D, w_C$  and  $L_C$  it is evident, that in our case inequality will also fall in terms of the *Gini* coefficient. It might be worth note though, that the ability-related process of acquiring human capital generally tends to describe a higher level of inequality than the static case. This is due to the slight fall in low-skilled wages which adjusts for the rise in supply of human capital. In the above figure we presented this fact by also including the Lorenz-Curve  $L_3$ , the one that does not include changes in the division of labor.

Besides the given results on inequality in the distribution of income, we are also able to analyze a second form of inequality endogenously determined in our model, the inequality of opportunities. In this framework, inequality of opportunities is determined by the different possibilities offspring of workers have to qualify, and thus depends on the extent of the parental externality. In the benchmark case with  $z(a^t, w^{t-1}) = 0$ , inequality of opportunities will be zero, with the same share of high and low-skilled workers deciding to invest into their human capital.

**Proposition 3.1.** *In the benchmark model which solely considers inter-industrial trade and inter-generational behavior in the absence of any parental externalities, trade will lower the existing income disparity both in terms of total factor incomes and the *Gini* coefficient. No inequality of opportunities is observed.*

We will now turn to examine the impact of the parental externality for our

model. For that, we again examine the benchmark case outlined so far. As we have a parental influence different from zero  $z(a^t, w^{t-1}) \neq 0$  it follows that the two ability rates characterizing the indifferent individuuum will differ between high-skill and low-skill offspring  $a_D^t \neq a_C^t$ . Hence the reaction of those ability rates to a change in high-skill or low-skill wages will also differ  $\frac{\partial a_D^t}{\partial w_D} \neq \frac{\partial a_C^t}{\partial w_D}$ ;  $\frac{\partial a_D^t}{\partial w_C} \neq \frac{\partial a_C^t}{\partial w_C}$ . We use a graphical description to review the effect of a change in wages on the "borderline" ability of children born to parents who differ in profession, the ability of an individual who is just indifferent between investing in its skills or not, that is. The figure shows to what degree of ability individuals that are born

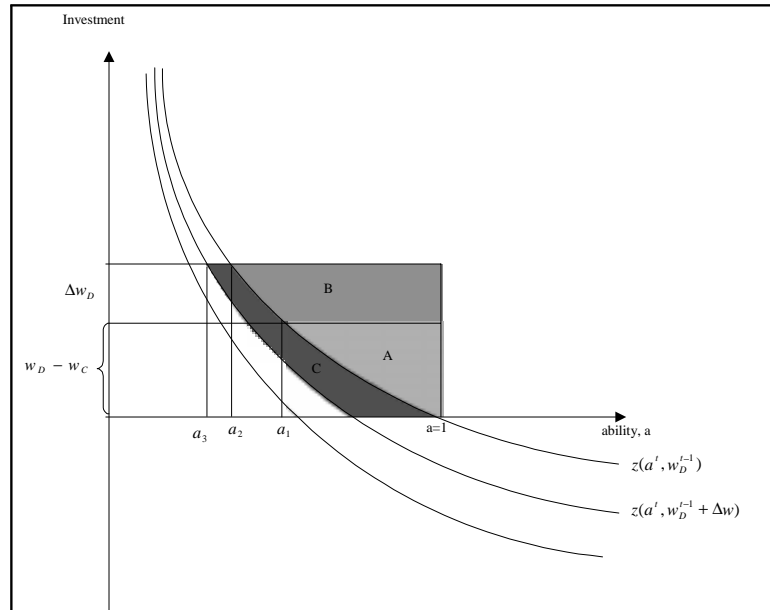


Figure 3.4: Changes in Distribution

to high-skilled parents have an incentive to invest in their skills. The vertical axis describes the size of an individuals investment according to its ability that is presented by the horizontal axis. The investment  $w_D - w_C$  represents the maximum possible investment individuals will undertake.

$$w_D - [I(a) - z(a^t, w^{t-1})] > w_C \quad (3.17)$$

Higher investments will not be profitable. Individuals until the ability of  $a_1$  will find that an investment in their skills pays off earn the total wage sum  $A$ . We now assume a rise in high-skill wages of the size  $\Delta w_D$ . Due to the increasing wage the incentive for individuals to become skilled will rise. This rise will effect both skilled and unskilled workers. The wage sum of skilled workers will rise to

$A + B$  and the ability necessary for investment will fall to  $a_2$ . The parental effect will remain unchanged in this generation, as the parent generation did earn only  $w_D$ . Still, due to the parental effect out of the next generation, a higher number of individuals will invest in their skills. The borderline level of ability needed, falls further to  $a_3$ , while the total wage sum earned by high-skilled offspring in the high-skilled sector will rise to  $A + B + C$ . This additional effect remains restricted to high-skill offspring. Thus a wage rise in the high-skilled industry will lead to a rising inequality of opportunities. In contrast to high-skilled offspring, in the low-skilled environment a smaller number of children born to low-skilled parents will undertake an effort to invest in their skills. In the common-goods sector the size of the low-skilled labor force is determined vice versa. As low-skilled wages rise, the incentive to invest in human capital will fall. This causes the ability-level, which leaves the individual indifferent to investment, to rise. The parental effect will again influence only the decisions of the next generations and will cause the borderline ability to fall, due to its decreasing effect on the investment needed to become high-skilled. The overall effect on the total wage sum earned by low-skilled individuals who will qualify for the high-skilled sector will remain ambiguous in this case.

As can be seen, the amount of a change in the low-skilled labor force will hence be dependent on the size of the parental effect which has an impact on the investment decision of both low- and high-skilled offspring. Below we will now review the effect on the low-skilled labor force  $dL_C^{t+1}$  given a parental effect  $z(a^t, w^{t-1}) \neq 0$  and given that trade will cause low-skilled wages to rise, while it forces high-skilled wages to fall  $dw_C > 0, dw_D < 0$ . We will use the expressions

$$\frac{\partial a_D^t}{\partial w_D} = \frac{\partial a_D^t}{\partial w_D^t} + \frac{\partial a_D^t}{\partial w_D^{t-1}} \quad (3.18)$$

and

$$\frac{\partial a_C^t}{\partial w_C} = \frac{\partial a_C^t}{\partial w_C^t} + \frac{\partial a_C^t}{\partial w_C^{t-1}} \quad (3.19)$$

to split up the effect of a wage change into its incentive and parental component.

$$\begin{aligned}
dL_C^{t+1} = & \overbrace{\frac{\partial L_C^{t+1}}{\partial a_D^t} \left[ \frac{\partial a_D^t}{\partial w_C} dw_C^\oplus + \frac{\partial a_D^t}{\partial w_D^t} dw_D^\ominus \right] + \frac{\partial L_C^{t+1}}{\partial a_C^t} \left[ \frac{\partial a_C^t}{\partial w_C^t} dw_C^\oplus + \frac{\partial a_C^t}{\partial w_D} dw_D^\ominus \right]}^{\oplus} \\
& + \left[ \frac{1 - a_C^t}{(1 - a_C^t + a_D^t)^2} \frac{\partial a_D^t}{\partial w_D^{t-1}} dw_D^\ominus + \frac{a_D^t}{(1 - a_C^t + a_D^t)^2} \frac{\partial a_C^t}{\partial w_C^{t-1}} dw_C^\oplus \right] \quad (3.20)
\end{aligned}$$

As one can see, due to the fall in high-skill and the rise in low-skill wages, the incentive to invest in human capital will fall in both sectors. This causes  $L_C^{t+1}$  to rise. With respect to the parental effect, the outcome is not immediately obvious. The effect of shrinking wages for high-skilled parents is opposed by a wage rise for low-skilled parents. This will evidently cause the gap in the inequality of opportunities between the two sectors to narrow. To draw a more accurate picture of the parental effect on the distribution of income, we will have to determine whether

$$\underbrace{\frac{1 - a_C^\oplus}{(1 - a_C^\oplus + a_D^\oplus)^2} \frac{\partial a_D^\ominus}{\partial w_D^{t-1}} dw_D^\ominus}_{HSPE} \leq \underbrace{\frac{a_D^\oplus}{(1 - a_C^\oplus + a_D^\oplus)^2} \frac{\partial a_C^\ominus}{\partial w_C^{t-1}} dw_C^\oplus}_{LSPE}. \quad (3.21)$$

Under the condition of diminishing returns to parental wealth, we will expect the change in the parental effect to be smaller for high-skilled offspring  $\frac{\partial a_D^\ominus}{\partial w_D^{t-1}} < \frac{\partial a_C^\ominus}{\partial w_C^{t-1}}$ . Yet, it remains unclear whether  $1 - a_C \leq a_D$  and how the change in relative prices will effect the absolute change in wages in the two sectors  $|dw_D| \leq |dw_C|$ . We will include two additional assumptions to solve this ambiguity. First, we assume that given an additional investment of  $K$ , the fall in the marginal product of capital is smaller in the diversified than in the common goods sector, hence capital is more important for the production of diversified goods. It follows that  $|dw_D| < |dw_C|$ . Second, we suppose that there are more unskilled than skilled workers in our society, with the implication that  $1 - a_C < a_D$ . Given these additional assumptions,

$$\begin{aligned} \frac{\partial a_D^\ominus}{\partial w_D^{t-1}} &< \frac{\partial a_C^\ominus}{\partial w_C^{t-1}} \\ |dw_D| &< |dw_C| \\ 1 - a_C &< a_D \end{aligned} \quad (3.22)$$

yields  $LSPE > HSPE$ . As a consequence, the low-skilled labor force will grow slower than it would without the parental effect. To see the effect on distribution we will again examine the Lorenz-Curve. As one can see, the change in wage structure will cause inequality to fall as we move from Lorenz-Curve  $A$  to  $B$ . The parental effect will cause a reduction of low-skilled labor force and hence further reduces inequality, yielding curve  $C$ . Interestingly we will expect the opposite effect if we measure inequality by the relative total factor income  $\frac{L_D^{t+1} w_D^{t+1}}{L_C^{t+1} w_C^{t+1}}$ . We can summarize our results on the parental effect on distribution in the benchmark case as follows:

**Proposition 3.2.** *In the benchmark case, given a parental influence on human capital formation, trade will lead to a fall in inequality of opportunities. Additionally, trade will lead to a decreasing dispersion of income. The size of this*

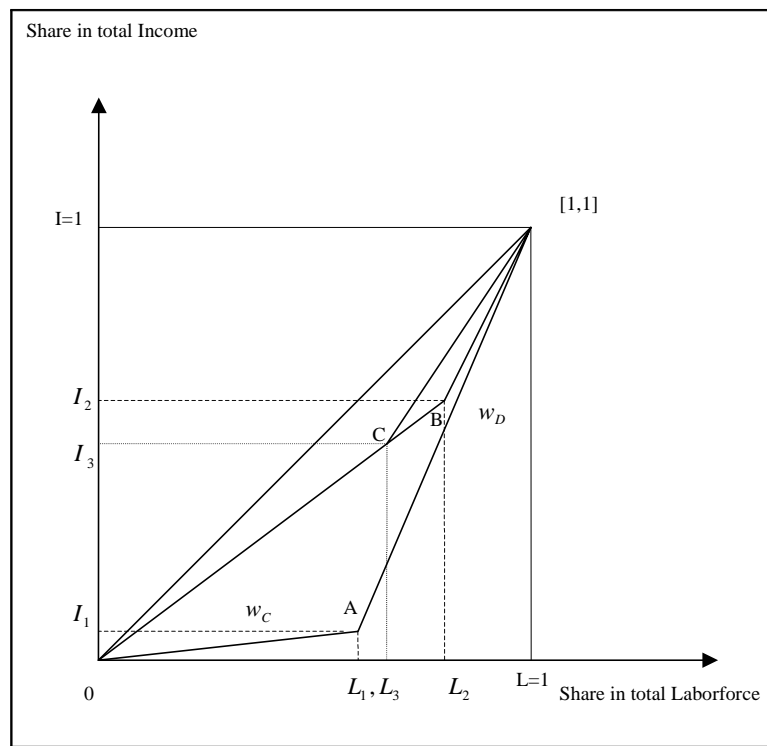


Figure 3.5: Interindustrial Trade and Inequality

decrease depends on whether and to what degree the effect of parental wealth on the individual investment decision can offset the influence the narrowing wage gap has on the incentive of individuals to invest. Given reasonable assumptions we observe that this shall be true for countries with a sufficiently large unskilled labor force.

### 3.2. Trade Between Similar Countries

In this subsection we will now consider intra-industrial trade with the number of goods produced in the diversified sector greater than one  $N = N^* > 1$ , positive production costs  $C$  in the diversified sector and  $0 < \theta < 1$  determining the degree of "love for variety" in society. On the other hand we will exclude the possibility of inter-industrial trade by assuming equal relative prices  $\frac{P_D}{P_C} = \frac{P_D^*}{P_C^*}$  for *Home* and *Foreign*.

We showed before that in *Home* and in *Foreign*

$$\frac{p_D}{p_C} = \frac{\frac{\partial v_D}{\partial c_D}}{\frac{\partial v_C}{\partial c_C}} n^{\frac{1-\theta}{\theta}}$$

has to hold. In the case of exclusively inter-industrial trade, equality in relative prices would be a reason for countries not to trade. Given the possibility of intra-industrial trade, the number of diversified goods available to consumers in *Home* will rise by the number of goods produced in foreign. This will shift the relative demand curve upwards, as we can observe in the next figure. Demand

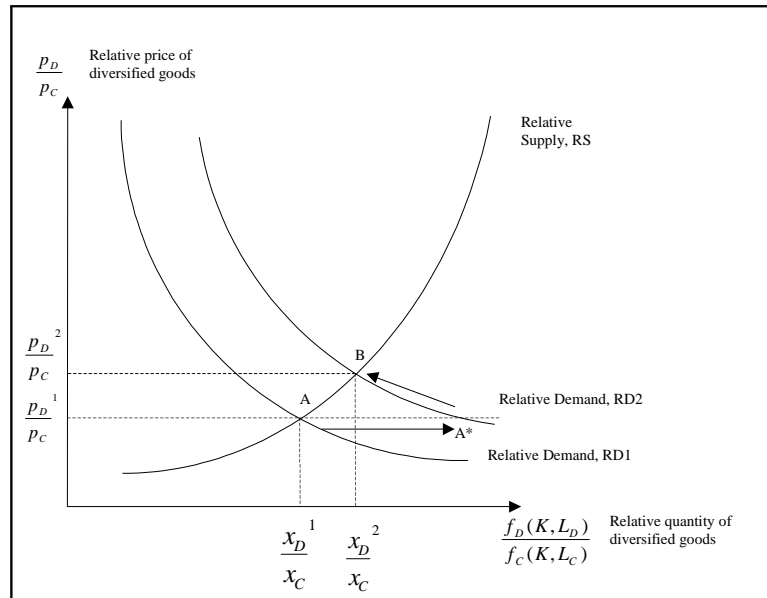


Figure 3.6: The Effect of Inter-Industrial Trade on Relative Prices

will thus move from  $A$  to  $A^*$  and, as the supply function, which only depends on the number of goods produced in *Home*  $n_{Home}$ , remains unchanged, will finally move to its new equilibrium point  $B$  where the relative supply equals the new relative demand. The move from  $A$  to  $B$  also implies a change in relative prices. As we saw in the last part of this paper, this will also have effects on the wage structure of our country: the relative price  $\frac{p_D}{p_C}$  rises and so does the amount of capital which is allocated to the diversified sector. This will cause the marginal product of capital in the diversified sector to shrink. With  $MPK_D \downarrow$  and  $K_D \uparrow$  and  $L_D$  remaining constant, we will also get a rise in the marginal product of labor  $MPL_D$ . If we now examine the income of workers in the diversified sector,

we can see that the real wages for high-skill work will rise.

$$\frac{w_D \uparrow}{P_D \uparrow} \uparrow = MPL_D \uparrow \left( \frac{f_D(K_D, L_D)}{f_D(K_D, L_D) + nC} \right) \uparrow \quad (3.23)$$

For determining the movement of wages in the common sector we use the results we gained in the last section and hence can show that

$$\dot{w}_D > \dot{P}_D > \dot{r} > \dot{P}_C > \dot{w}_C$$

has to hold. As a result, we can state that in a model that examines two different sectors, one of which produces under perfect competition, while the other one follows monopolistic competition, the rents of two industry specific factors are determined in the following way: given a relative price change, workers in one sector will experience rising real wages, while the income of workers in the other sector will fall.

We shall turn to the consequences that the observed wage changes caused by intra-industrial trade will have on the distribution of income. As wages will move exactly in the opposite direction than in the previous case, we shall expect inequality to rise. To answer this question, we first have to determine the size of the different labor forces after the price change occurred. For this we leap back to the total partial differentiation we derived before. Given the new development of wages, we can observe the following effects:

$$\begin{aligned} dL_C^{t+1} &= \overbrace{\frac{\partial L_C^{t+1}}{\partial a_D^t} \left[ \frac{\partial a_D^t}{\partial w_C} dw_C + \frac{\partial a_D^t}{\partial w_D} dw_D \right]}^{\ominus} + \frac{\partial L_C^{t+1}}{\partial a_C^t} \left[ \frac{\partial a_C^t}{\partial w_C} dw_C + \frac{\partial a_C^t}{\partial w_D} dw_D \right] \\ &+ \left[ \frac{1 - a_C^t}{(1 - a_C^t + a_D^t)^2} \frac{\partial a_D^t}{\partial w_D^{t-1}} dw_D + \frac{a_D^t}{(1 - a_C^t + a_D^t)^2} \frac{\partial a_C^t}{\partial w_C^{t-1}} dw_C \right] \quad (3.24) \end{aligned}$$

The first part denotes what we previously called the incentive effect. Individuals will be the more willing to invest in their human capital the larger the wage gap they are confronted with. We can observe that a wage rise in the diversified sector and a fall of wages in the common sector will make an investment for a part of the labor force more attractive. On the other hand, we again need to deal with the parental effect. We notice that the wage gap widens and so does the inequality of opportunities. While more high-skilled offspring get the opportunity to invest in their skills, children of low-skilled parents will find it increasingly less

attractive to get educated. Given the additional assumptions, we proposed above, namely:

$$\begin{aligned} \frac{\partial a_D^t}{\partial w_D^{t-1}} &< \frac{\partial a_C^t}{\partial w_C^{t-1}} \\ |dw_D| &< |dw_C| \\ 1 - a_C &< a_D \end{aligned}$$

We are now able to show that the parental effect will increase the low-skilled labor force. To review the consequences of that effect, we once more examine the properties of the Lorenz-Curve.

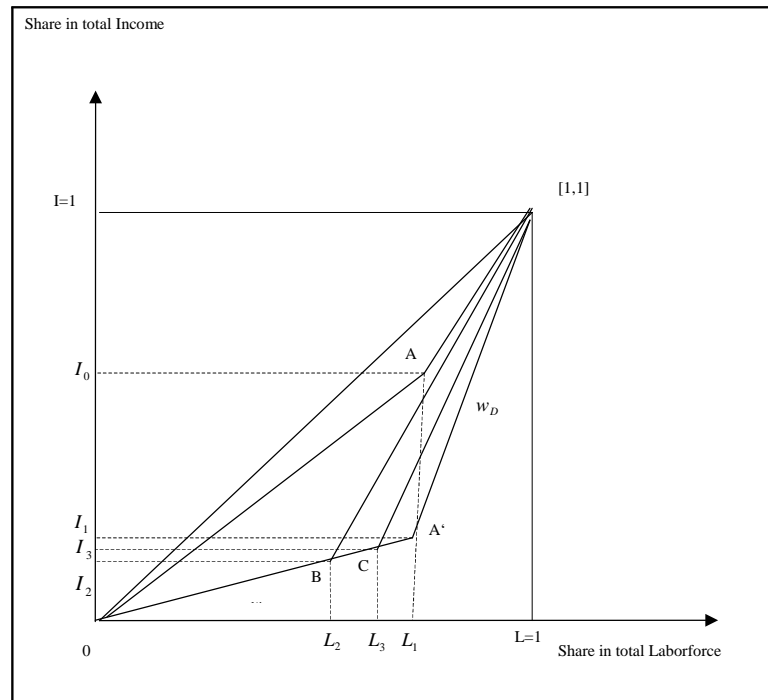


Figure 3.7: Intraindustrial Trade and Inequality

The change in wages will cause income inequality as expressed by the *Gini* coefficient to rise. We can see this by looking at the different Lorenz-Curves shown above. The initial distribution is represented by curve *A*. As wages change, inequality rises. The new curve is shown to move to *B*. The parental effect will further increase inequality to the curve corresponding to point *C*. The total factor income of the educated can be expected to rise, while that of the unskilled will fall.

It needs to be stressed that this result is only true, if we have a sufficiently large low-skill labor force. As the share of the high-skilled grows, the last of the additional assumptions,  $1 - a_C \not\leq a_D$  will not hold anymore. That means, that as intraindustrial trade increases, in a country which is comparatively well-endowed with high-skilled labor, income inequality will rise to a smaller extent and eventually might even fall. We will return to this case at a later point of this work when we will extend our model to include inequality across countries.

**Proposition 3.3.** *In a modified specific factor model, trade between similar countries will cause a rise in the relative price of diversified goods. As the inclusion of a sector of monopolistic competition will not change the way wages react to changing prices, it can be shown, that intra-industrial trade will leave those working as skilled better off while it will cause the real wages of the unskilled workers in common goods sector to fall. As a consequence, in countries which are relatively well endowed with low-skill labor, intra-industrial trade will cause the inequality of income that is measured by the Gini coefficient and by the relation of total factor incomes, to rise. Inequality in opportunities will rise and reduce the inter-generational migration of individuals between the two sectors.*

### 3.3. The Joint Effect of Inter- and Intra-Industrial Trade

As a final step, we will now consider the case in which countries experience both, inter- and intra-industrial trade. We expect this to happen, if the number of goods produced by the diversified sector in *Home* and *Foreign* both exceed one, but are not necessarily identically, and if the relative price of goods in the two sectors differ.

$$\begin{aligned} N &\leq N^* > 1 \\ \frac{P_D}{P_C} &\leq \frac{P_D^*}{P_C^*} \end{aligned} \tag{3.25}$$

Again, we suppose *Home* to be relatively well-endowed with low-skill labor and thus to initially have a higher relative price for diversified goods  $\frac{P_D}{P_C}$  than *Foreign*. Inter-industrial trade will cause the relative price of goods to fall as the relative supply curve in the following figure shifts from  $RS_1$  to  $RS_2$ . The shift in demand due to intra-industrial trade will have the opposite effect and rise the price relation as society moves from  $RD_1$  to  $RD_2$ . We can see that the new relative price which emerges as a result of trade, will realize in the shaded area. Still it is not quite obvious whether prices will rise and lie in the upper, dark area or if prices will fall and the resulting price-quantity equilibrium will be part of the lower, lighter-shaded triangle. For the latter to happen, the demand-effect has to be offset by the supply-effect. This is the case when the amount of new goods, which a country will benefit from by trade, is relatively small compared to the effect of

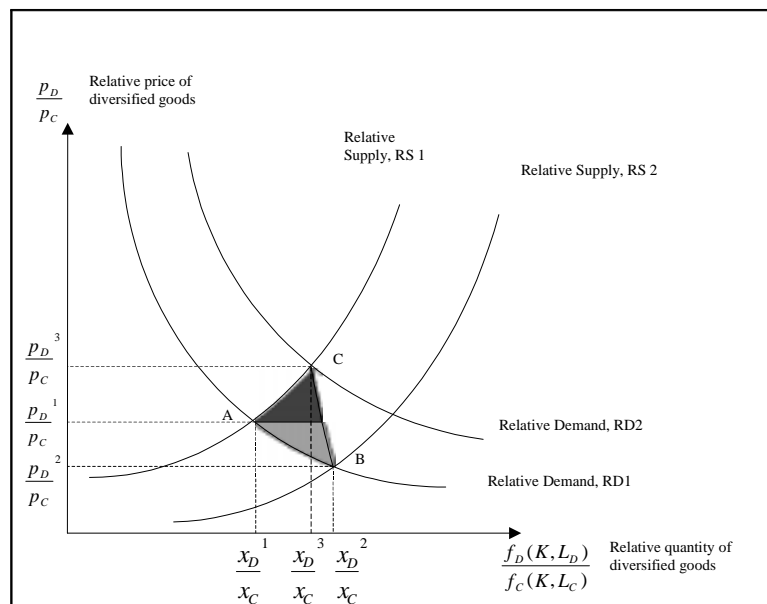


Figure 3.8: The Effect of Trade on Prices

comparative advantage. This will apply, if the two countries, that trade, supply only a small number of diversified goods.

**Proposition 3.4.** *We can state that the equalizing effect, that inter-industrial trade has on the distribution of income in countries that are relatively well-endowed with low-skilled labor, will be weakened if not offset by the influences of intra-industrial trade. Yet, within this paper we do not derive any results on the degree of total welfare a country is going to experience due to trade. It might be the case that, as trade extends the consumption possibilities of all individuals the overall effect of trade on the welfare of a country will be positive. Still the effect of trade, and especially intra-industrial trade is not as clear cut as it has been presented in the past (Krugman 1981).*

#### 4. The Distribution of Income Across Countries

Until now, we were only concerned with the case of two countries. In this section of our paper, we will try to roughly sketch how in the framework of our model trade can influence the distribution of income inequality *across* nations. As the pattern of trade is mainly determined by a country's initial factor endowment and its given initial conditions we shall ask whether our model can predict the distribution of income inequality across countries. As one might recall, we assumed a concave

structure for our parental-influence function  $z(a_i^t, w^{t-1})$ . An immanent result is that the same wage gap between wages in the diversified and the common goods sector can have different effects depending on the average wages in both countries. If we assume equal abilities across countries, differences in average wages can only be caused by different initial allocations of capital and labor. Countries which are relatively well-equipped with labor experience a lower relative price of labor compared to capital. We shall hence expect the parental effect in poor countries, which are often overpopulated, to be stronger than in countries which have a higher capital to labor ratio. Thus, rich countries on the one hand and poor countries on the other hand will tend to behave similar.

$$\underbrace{\frac{1 - a_C^t}{(1 - a_C^t + a_D^t)^2} \frac{\partial a_D^t}{\partial w_D^{t-1}} dw_D}_{HSPE} + \underbrace{\frac{a_D^t}{(1 - a_C^t + a_D^t)^2} \frac{\partial a_C^t}{\partial w_C^{t-1}} dw_C}_{LSPE}$$

If we concern trade among wealthy countries, we have to change the additional assumptions made in order to be able to determine the overall direction of the parental effect. As we consider a country which is relatively well-endowed with capital, we expect both high-skill and low-skill wages to be higher. As a consequence, the resulting change in the ability-level which will just be sufficient for high-skilled jobs, given a change in parental wealth, will be approximately the same in both sectors. If, in addition, the country has a relatively large high-skill labor force, we are unable to determine whether the *HSPE* will be outweighed by the *LSPE* or vice versa. The conditions we will now expect to hold are:

$$\frac{\partial a_D^t}{\partial w_D^{t-1}} \approx \frac{\partial a_C^t}{\partial w_C^{t-1}} \text{ and } |dw_D| < |dw_C| \text{ and } 1 - a_C > a_D \quad (4.1)$$

Given a country is sufficiently well-equipped with capital and high-skill labor, we can believe the *HSPE* to prevail. As a consequence in developed countries intra-industrial trade will lead to a smaller rise in inequality than in poor countries. Since the smaller rise in inequality goes along with a potentially smaller size of low-skilled labor force, we may expect the average income to grow faster.

These results lead us to a generalized model which can describe not only the effect of trade on the distribution of income within countries but which also provides an explanation for the emergence of different clusters of income distribution across countries. Empirical evidence as provided by Quah (1996,1997) and Ben David (1997) support the theory of convergence clubs in economic growth on "top" as well as on the "bottom" of the national income ladder. Further research is needed to provide additional evidence on this question both theoretically and empirically. The extensions to the model as outlined before may seem to be even more preferable if we consider that inequality in-between countries accounts for two third of the worlds income inequality (Schulz 1998).

## 5. Concluding Remarks

The objective of the paper presented was, to analyze the influence of different trade regimes on the distribution of income. As we have seen in the second chapter of our work, there is a wide variety of opinions in both the empirical and theoretical literature when it comes to determine the effect of free trade on the factor income over time. With rising rates of inequality across the world, standard trade theory, as the Stolper-Samuelson and the Heckscher-Ohlin theorem are increasingly unable to explain those changes. In the second section of this paper a trade based model is used to explain the observed widening of the income gap. In the model presented, differences in the income effects of different trade regimes play a major role. As countries increasingly turn to intra-industrial trade the existing equalization effect of inter-industrial trade is substantially reduced if not reversed. We put these results to practice by including a sector that produces a variety of diversified goods under monopolistic competition into a specific factor model framework, where the other sector remains entirely competitive, with high- and low-skilled labor as specific factors. With individuals having a "love for variety" in goods consumed, we were able to show that an increase in variety results in rising relative product prices and thus causes wages of high-skilled workers to rise and those of low-skilled ones to fall. This change in factor prices was then used to determine the resulting change in the distribution of human capital and income, within a dynamic overlapping generations framework. The process of human capital accumulation used was based on individuals investing in their personal abilities to become high-skilled. Besides that, we introduced a parental wealth bias by relating the size of an investment in human capital one needs to undertake to become skilled to parental wealth. It was shown that a rise in high-skilled wages causes rising inequality of individual opportunities. We were able to conclude that the inclusion of intra-industrial trade can lead to higher overall rates in inequality in both, industrialized and developing, countries. Yet, we found this increase to be smaller for industrialized countries.

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