

Bartholomae, Florian W.

**Working Paper**

## Trade And Pension Systems

Diskussionsbeiträge, No. 2006,1

**Provided in Cooperation with:**

Bundeswehr University Munich, Economic Research Group

*Suggested Citation:* Bartholomae, Florian W. (2006) : Trade And Pension Systems, Diskussionsbeiträge, No. 2006,1, Universität der Bundeswehr München, Fachgruppe für Volkswirtschaftslehre, Neubiberg

This Version is available at:

<https://hdl.handle.net/10419/23030>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

# Trade And Pension Systems\*

Florian W. Bartholomae<sup>†</sup>

Universität der Bundeswehr München

Diskussionsbeiträge des Instituts für Volkswirtschaftslehre

18. Jg. (2006), Nr. 1

---

\*Presented at the ETSG Eight Annual Conference 2006 in Vienna.

<sup>†</sup>Address: Dipl.-Vw. Florian W. Bartholomae, Fakultät für Wirtschafts- und Organisationswissenschaften, Universität der Bundeswehr München, D-85577 Neubiberg, Germany, phone: +49-89-6004-4283, fax +49-89-6004-2374, e-mail: [florian.bartholomae@unibw-muenchen.de](mailto:florian.bartholomae@unibw-muenchen.de)



## **Abstract**

This article concentrates on the possible relationship between trade and pension systems. I consider trade between a capital-abundant home and a labor-abundant foreign country. The underlying model is a two-period overlapping generations-model augmented with factor-price changes resulting from price-variations through globalization. First, I analyze the resulting income effects of the young generation and of the retirees in a pay-as-you-go (PAYG) pension system and a fully funded pension system. Considering contribution rates and population growth, the retirees might improve their income situation in a fully funded system. Second, I analyze the effects on life income when a pension system change is implemented simultaneous with the reduction of trade barriers. A less expensive change can be expected, if free trade is permitted.

### Keywords:

Pay-as-you-go pension system, fully funded pension system, Heckscher-Ohlin-Samuelson, trade with low-wage-countries

JEL-classifications: F10, H55

## **Zusammenfassung**

Dieser Aufsatz versucht einen Zusammenhang zwischen Handelsbeziehungen und dem Rentensystem herzustellen. Untersucht wird dabei der Handel zwischen einem kapitalreichen Inland und einem arbeitsreichen Ausland in einem zweiperiodigen OLG-Model, erweitert durch handelsinduzierte Preisänderungen. Es gibt dabei Auswirkungen auf das Einkommen der jungen sowie der in Rente befindlichen Generation im Umlageverfahren (UV), sowie im kapitalgedecktem Rentensystem (KDV). Während das Einkommen der Rentner im UV teilweise vom Faktor Arbeit abhängt, der durch die Handelsaufnahme verliert, besteht es im KDV lediglich aus Kapital, das durch die Liberalisierung gewinnt. Zieht man das Bevölkerungswachstum mit ins Kalkül, so können sich die Rentner im KDV besser als im UV stellen. Im zweiten Teil wird untersucht, inwieweit ein Umstieg vom UV auf das KDV durch Handelsliberalisierungen erleichtert werden kann.

### Schlagworte:

Umlageverfahren, Kapitalgedecktes Rentensystem, Heckscher-Ohlin-Samuelson, Handel mit Niedrig-Lohn-Ländern

JEL-Klassifikationen: F10, H55

# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
<b>2</b>	<b>Definition of PAYG and fully funded pension system</b>	<b>2</b>
<b>3</b>	<b>Effects of trade-induced price-variations</b>	<b>6</b>
<b>4</b>	<b>Trade and pension systems</b>	<b>7</b>
<b>5</b>	<b>Change of Pension System</b>	<b>10</b>
<b>6</b>	<b>Concluding Remarks</b>	<b>12</b>
<b>A</b>	<b>Appendix</b>	<b>16</b>
	A.1 Percentage Saving . . . . .	16
	A.2 Total national income . . . . .	16
	<b>References</b>	<b>17</b>



## 1 Introduction

In this article I present an application of the distribution conflict resulting from trade on a new issue, which is getting more and more important. Since most western populations are aging and pay-as-you-go pension systems are not able to face demographic pressure, a change to a fully funded pension system has been taken into consideration in many countries. Such a reform may lead to a change in the structure of capital and labor owners. The effects of *inter*industrial trade on income distribution of factors are therefore an interesting topic under consideration of a pension system change. I analyze in this paper which conditions have to be fulfilled for a positive effect from trade on the generation of employees and the generation of retirees. Figure 1 shows the dependency ratios—the rate of persons older than 65 years to persons aged 15–64—of the MDC (More Developed Countries) and the LDC (Less Developed Countries) as they are classified by the UN (2006). The figure proves that aging of society is concerning developed countries as well as the less developed world. Problems will occur since the dependency ratio will converge 50% in the year 2050.<sup>1</sup>

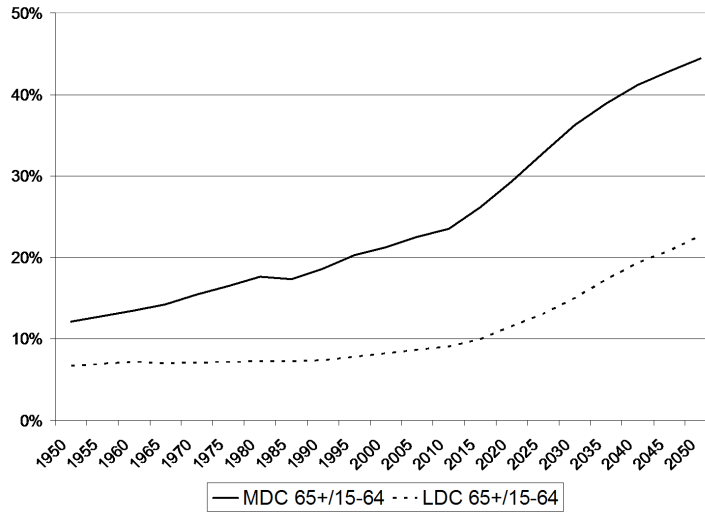
In section 2, I explain how fully funded and pay-as-you-go (PAYG) pension systems work. Section 3 then shows the effects of trade-induced price changes on factor wages as they are known from the Stolper-Samuelson theorem. In section 4, I show the effects of trade liberalizations on both pension systems as well as implications for trade policy. The implications for a system changeover when trade liberalizations took place are shown in section 5. Section 6 gives some remarks on the model and concludes.

---

<sup>1</sup>The Overall dependency ratio—the ratio of people aged 65 and older *plus* those aged 14 and younger to persons aged 15–64—was in 1950 54.39% in MDC and 71.01% in LDC. 2005 this ratio fell to 47.65% and 56.93%. According to UN estimations the overall dependency ratio will increase in the MDC to 71.21% and decrease in the LDC to 55.05% until 2050. The ratio of people aged 65 and older to those aged 14–64 increased in both, the LDC and the MDC. From 1950 to 2050, it will increase in the MDC from 22.36% to 62.38% and in the LDC from 9.43% to 41.11%. The rates for 2005 are 47.34% and 15.25%. Source: UN 2006, own calculations.



Figure 1: Dependency ratios



Source: United Nations (2006), own calculation

## 2 Definition of PAYG and fully funded pension system

The two pension systems have to be defined in terms of this model.<sup>2</sup> According to Sinn (1999), the definition of a PAY-AS-YOU-GO PENSION SYSTEM in a two-periods-overlapping-generations model is:

1. Pensions are financed through the contributions of the young employed generation of the current period,

$$N_t^Y C_t = N_t^P P_t.$$

2. Today's contributors are tomorrow's retirees,

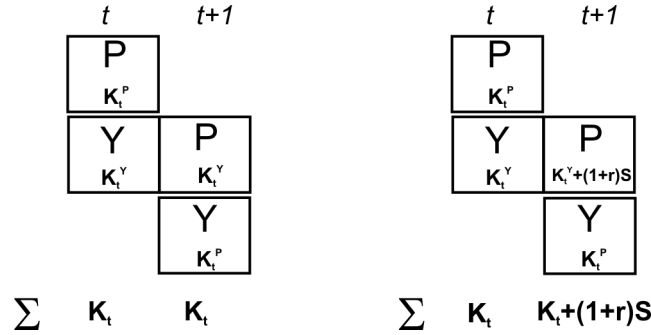
$$N_t^Y = N_{t+1}^P.$$

The subscript denotes the period and the superscript indicates the affiliation of the group. Let  $N_t^Y$  be the number of young, working individuals at time  $t$ ,  $C_t$  the lump-sum contribution per capita,  $N_t^P$  the number of retirees at time  $t$  and  $P_t$  the pension per capita.

This is a very general approach to the pay-as-you-go pension system, since these equations

<sup>2</sup>To keep this model as simple as possible, several, nonetheless important, aspects of pension systems are ignored. Some of these aspects are for example the redistribution ambitions among individuals of the same generation or the widely discussed consideration of the benefits of the first generation. Furthermore a constant pension is assumed. This means the rate of return is zero (see Siebert 1997).

Figure 2: Capital stock in pay-as-you-go (left) and fully funded pension system (right)



Source: Author's model

do not consider the connection between contributions and wages. The aggregate income of the employed generation is

$$wL + rK - cwL,$$

whereas  $w$  is the wage,  $L$  is the labor supply,  $r$  is the capital rent,  $K$  is the endowment of capital of the young and  $c \in (0, 1[$  is the contribution rate to the pension system in percentage terms of their wage.

Two periods,  $t$  and  $t + 1$ , are assumed in this analysis. In the PAYG scenario the retirees,  $\mathbf{P}$ , are endowed with  $K_t^P$  and the young,  $\mathbf{Y}$ , with  $K_t^Y$ , both add up to  $K_t$ , which shows the total endowment of the economy. Neither saving, nor depreciation are assumed in the economy. Thus, the total capital endowment won't change in  $t + 1$ . The young of  $t$  are the retirees of  $t + 1$ . They will still own their capital  $K_t^Y$ , while the released capital of the retirees of  $t$  is distributed ("bequeathed") to the young in  $t + 1$ . The described situation is illustrated in figure 2. For simplicity there is no unemployment assumed and all members of the young generation are working. For obtaining the income of the young in  $t$ ,  $I_t^Y$ ,  $L$  can be substituted by  $N_t^Y$ ,

$$I_t^Y = w_t(1 - c) N_t^Y + r_t K_t^Y. \tag{1}$$

The income of the retirees in  $t$  consists in their pension—the contributions of the young—as well as in their capital income,

$$I_t^P = cw_t N_t^Y + r_t K_t^P. \tag{2}$$

Next the growth rate of the population is considered. If the young generation remains childless, no one could pay the pensions of the retiree generation in the next period. Furthermore, this model assumes that only the young are fertile. This means that the number of the young in the next period is a function of the number of the young in the present period.<sup>3</sup> Let  $n$  denote the exogenously determined population growth rate,

$$(1 + n) N_t^Y = N_{t+1}^Y \quad \text{or} \quad (1 + n) N_t^P = N_t^Y,$$

therefore it results that if

$n < 0$ , ratio of retirees to young increases,

$n = 0$ , ratio of retirees to young remains constant,

$n > 0$ , ratio of retirees to young decreases.

There exist many studies about the effects of population growth on the income of the young and the retirees in a PAYG pension system. The main finding e.g. for Germany is, that the pension payments will decrease to 50% for constant contributions or the contribution rates will be doubled for maintaining the present pension level (see e.g. Börsch-Supan 1997).<sup>4</sup>

In the FULLY FUNDED PENSION SYSTEM, the young have to save money during their working life. When they retire, they will own more capital than in the PAYG scenario. The endowment in  $t$  does not differ from PAYG system but the situation in  $t + 1$  is varying. This is shown in figure 2. Unlike in a pay-as-you-go system, in a fully funded system an *intertemporal*, rather than an *intergenerational*, redistribution takes place. Consumption after retirement is just possible under the condition of savings during working life. In formal terms, let  $S$  denote the saving deposit, to get the (disposable) income of the young,<sup>5</sup>

$$I_t^Y = w_t N_t^Y + r_t K_t^Y - S_t, \quad (3)$$

<sup>3</sup>Assuming there is no migration possibility, this will be consistent with the key assumptions of the Heckscher-Ohlin-Samuelson-model.

<sup>4</sup>By rearranging the first condition of the pay-as-you-go system, it results  $C_t = (N_t^P/N_t^Y) P_t$  or  $c = (N_t^P/N_t^Y) (P_t/w_t)$ . The dependency ratio,  $N_t^P/N_t^Y$ , will more than double for Germany, comparable to the findings in figure 1. Thus *ceteris paribus* either you double the contributions to the system or you reduce the pension payments to the half of their current level. Both scenarios are intolerable.

<sup>5</sup>A completely inelastic supply of labor is assumed. Otherwise labor supply might be higher in a fully funded system compared to a PAYG pension system since the net wage is higher.

and the income of the retirees,

$$I_t^P = r_t K_{t-1}^Y + r_t (1 + r_t) S_{t-1}. \quad (4)$$

Equation (3) shows, that the young save the lump-sum  $S$  of their available income (and therefore consume less). If you compare (3) with (1), you see that now the burdened factor has changed: the pay-as-you-go system burdens the labor, whereas the fully funded system “burdens” the whole income. The situation of the retirees is shown in equation (4). First they have the remaining capital from their youth. Second there is their saving deposit *and* the rental earnings. They will live from the rental payments in favor of consuming their capital. Thus, the whole capital stock in the economy is increasing by  $rS$ . By comparing (4) with (2) it can be observed that the income of the retirees no longer depends on the factor labor.<sup>6</sup> Hence, the demographic aspect does not influence their income any longer.<sup>7</sup> Cigno (1993) emphasizes the role of altruism for such a capital-based pension system for avoiding the extinction of the population after introduction.

For the later analysis it is useful to express equations (1) to (4) in per-capita-notation. Thus I divide the aggregate incomes simply by the number of the relevant group. I get the per-capita-income in a pay-as-you-go system for the young from (1),

$$I_t^Y / N_t^Y = w_t (1 - c) + r_t \frac{K_t^Y}{N_t^Y}, \quad (5)$$

and for the retirees from (2),

$$I_t^P / N_t^P = c w_t (1 + n) + r_t \frac{K_t^P}{N_t^P}. \quad (6)$$

And I get the per-capita-income in a fully funded pension system for the young from (3),

$$I_t^Y / N_t^Y = w_t + \frac{r_t K_t^Y - S_t}{N_t^Y}, \quad (7)$$

and for the retirees from (4),

$$I_t^P / N_t^P = r_t \frac{K_{t-1}^Y + (1 + r_t) S_{t-1}}{N_t^P}. \quad (8)$$

<sup>6</sup>Indirectly it depends on labor, since a part of the retirement-income based on the work-income, which partly depends on the labor supply.

<sup>7</sup>If capital mobility is given, diverging population growth rates in different countries are influencing the fully funded system (see Börsch-Supan 2003). However, this is not the focus of this article.

### 3 Effects of trade-induced price-variations

Next, I assume an increasing trade relationship with low-wage-countries. These may result from new trade partners, growing existing trade partners or from vanishing trade barriers. This is considered by using a standard 2x2x2-Heckscher-Ohlin-Samuelson-Model (HOS). There are two production factors, capital<sup>8</sup>,  $K$ , and labor,  $N$ . Two goods are produced, a capital-intensive High-Tech good,  $H$ , and a labor-intensive Low-Tech good,  $L$ . Finally there are two countries, the home country and the foreign country. Foreign in this case might be China or some newly industrializing economies. Furthermore the key assumptions of the HOS-model are valid: constant returns to scale of production, identical production technologies in both countries, the production factors are immobile between both countries<sup>9</sup>, but perfectly mobile between the two perfect competitive sectors (in a country) and finally there exist no transportation costs. Home is assumed to be capital-abundant, whereas Foreign is labor-abundant. Trade will lead to an increasing price of the capital-intensive High-Tech-good in Home and to a decreasing price of the labor-intensive Low-Tech-good, vice versa will happen in Foreign. The connection between good prices and factor prices was shown by the Stolper-Samuelson-Theorem:

*If both goods continue to be produced, an increase in the relative price of a good will increase the real return to the factor used intensively in the production of that good and decrease the real return to the other factor of production.*<sup>10</sup>

---

<sup>8</sup>For simplicity,  $K$  is only physical capital and not human capital.

<sup>9</sup>Although this assumption is not realistic, it is very important for the HOS model. Labor, especially in the low-skilled sectors, is not mobile between countries. Labor mobility is sometimes not even given among national regions (see Europe). Capital therefore should be mobile. However, Feldstein and Horioka (1980) found empirical evidence that capital is not as mobile as widely supposed. They found a kind of home-bias, which leads to higher preferences that capital is spent in the home country (see also French and Poterba 1991). Hence this assumption is not as wrong as it might appear at first glance.

<sup>10</sup>For a short survey on this theorem see McCulloch (2005).

In this example, the increase of the relative price of the High-Tech-good will lead to declining wages,  $w$ , and to rising capital rents,  $r$ .<sup>11</sup> In formal terms the relation can be expressed as<sup>12</sup>

$$w = w \left( \frac{P^H}{P^L} \right), \text{ where } w' < 0 \text{ and} \quad (9)$$

$$r = r \left( \frac{P^H}{P^L} \right), \text{ where } r' > 0. \quad (10)$$

Several aspects have to be considered for guarantying the validity of the Stolper-Samuelson-theorem. First, both countries must produce the same homogeneous goods without quality differences. This presumption is not fulfilled if you consider the trade relationship between Europe and China. Europe imports many goods that are no longer produced in Europe, e.g. textiles. Second, factor endowment points of both countries have to be situated within the *cone of diversification*. Section 6 will show under which conditions these assumptions may be violated. However, for the rest of this paper it is assumed that the economy is within the *cone*. Furthermore, both Home's and Foreign's endowment points are within the *cone*.

## 4 Trade and pension systems

In this section a connection between the pension systems described in section 2 and the price variations induced by trade shown in the previous section is considered.<sup>13</sup> First I analyze how the price changes generated by trade will affect the income of both age cohorts in a PAYG pension system. Insert (9) and (10) in (5) to get the *per-capita income of the young*. Then I examine how income is affected by price changes. Therefore differentiate for  $P^H/P^L$  to get

---

<sup>11</sup>Deardorff (1987) simulates a model based on Solow where capital accumulation and diverging population growth rates between the North (in our example Home) and the South (low-wage country) take place. Therefore  $r$  decreases worldwide in the long run and  $w$  increases as labor becomes the scarce factor. Further, this implicates that the trade pattern will change (in Deardorff's case many goods are assumed). Home will lose labor-intensive industries and keep the most capital-intensive industries. A fully funded pension system increases the propensity to save in Deardorff's simulations.

<sup>12</sup>Note, that  $f'$  is short for  $\partial f(x)/\partial x$ .

<sup>13</sup>This procedure is possible since any redistribution, such as pension systems, will have no influence on prices—and therefore also on the *cone*—and hence factor incomes under free trade, see Walz and Wellisch (1998).

the first order condition,

$$\frac{\partial (I^Y/N_t^Y)}{\partial (P^H/P^L)} = (1 - c) w' + \frac{K_t^Y}{N_t^Y} r'.$$

There are three cases to be distinguished,

$$r'K > -N_t^Y(1 - c)w', \quad \text{per-capita income of the young increases,}$$

$$r'K = -N_t^Y(1 - c)w', \quad \text{per-capita income of the young remains constant,}$$

$$r'K < -N_t^Y(1 - c)w', \quad \text{per-capita income of the young decreases.}$$

Young people's benefit from trade is bigger in a pay-as-you-go system with high redistribution than in a PAYG system with low contribution rates.<sup>14</sup>

For calculating the *per-capita income of the retirees* insert (9) and (10) in (6), which leads to the first order condition

$$\frac{\partial (I^P/N_t^P)}{\partial (P^H/P^L)} = c(1 + n_t) w' + \frac{K_t^P}{N_t^P} r'.$$

Distinguish three cases,

$$r'K_t^P > -N_t^P c(1 + n_t)w', \quad \text{per-capita income of the retirees increases,}$$

$$r'K_t^P = -N_t^P c(1 + n_t)w', \quad \text{per-capita income of the retirees remains constant,}$$

$$r'K_t^P < -N_t^P c(1 + n_t)w', \quad \text{per-capita income of the retirees decreases.}$$

Thus, the higher the contribution rates or the higher the population growth, the higher the probability that the retirees will lose from increased trade relationships.

In a system with high redistribution, the retirees will get more of the factor that will lose from trade (in this case labor) compared to a system with lower redistribution. Unlike the retirees, the young generation will have less of the losing factor labor and more of the winning factor (as share of their total income). Thus, the young will benefit from trade. Please note that several PAYG pension systems with continuous contribution rates are considered. The contribution rate is assumed to be constant. I analyze for which of this systems, trade might be advantageous. Higher contributions will lead to a lower overall income of the young.<sup>15</sup> The higher the contribution rates in a pay-as-you-go pension system, the more redistribution takes

<sup>14</sup>Since  $w' < 0$ , both sides are positive.

<sup>15</sup>You may compare this situation to a portfolio problem: There exist two shares,  $L$  and  $K$ . The rate of return of  $L$  is negatively correlated to the rate of return of  $K$ . A special situation leads to a positive return of  $K$  and therefore

place, the higher the probability that the retirees won't agree trade liberalizations with low-wage countries. A low (negative) population growth rate means, that there is a higher share (majority) of retirees in the population. However, low values of  $n$  imply that trade might be advantageous for the retirees. A situation with contribution rates exceeding a critical value, retirees having a majority (assuming for the moment a negative  $n$ ), where retirees are disadvantaged by trade, is possible.<sup>16</sup> Politicians, who want to serve another term, will then provide protectionist laws. If there are high values of  $n$  (this implies a majority of the young) and low values of  $c$ <sup>17</sup> the young will oppose trade liberalizations.<sup>18</sup>

Next, the effects in a fully funded pension system, using the same approach as above, are considered. For this purpose the *per-capita income of the young* is calculated by inserting (5) and (10) in (7). Subsequently differentiate for price changes to get

$$\frac{\partial (I^Y / N_t^Y)}{\partial (P^H / P^L)} = w' + r' \left( \frac{K_t^Y}{N_t^Y} \right).$$

Three different cases result,

$$r' K_t^Y > -w' N_t^Y, \quad \text{per-capita income of the young increases,}$$

$$r' K_t^Y = -w' N_t^Y, \quad \text{per-capita income of the young remains constant,}$$

$$r' K_t^Y < -w' N_t^Y, \quad \text{per-capita income of the young decreases.}$$

---

a negative return of  $L$ . Depending on the shares in a portfolio, there arises a net gain or a net loss. Now compare two individuals, a rich one and a poor one. The rich has relatively more  $L$ , while the poor has relatively more  $K$  in his portfolio. The rich will loose and the poor will win independent of their wealth. Here I only consider the net effect.

<sup>16</sup>According to Browning (1975) negative values of  $n$  imply that the median voter is aging. An aging median voter, however, tends to vote for higher contribution rates since he will benefit from higher pensions, but has not to bear the whole burden. The young are against higher contribution rates, because they have to bear the tax burden for their working life without any further gains. If population growth is negative, retirees will vote for a higher contribution rate, but this will make them more sensitive to price shocks through trade. Either they consider this problem in their voting behavior or they ignore it and vote instead for further trade barriers. The outcome might be ambiguous, if the level of redistribution is endogenous.

<sup>17</sup>This results from the majority owned by the young, compare footnote 16.

<sup>18</sup>The empirical relevance of Heckscher-Ohlin based income redistributions on attitudes towards globalization is shown in O'Rourke (2003). The abundant factor in a country tends to be more liberal towards trade as well as towards immigration.



The saving deposit is irrelevant in this consideration since saving is a lump-sum transfer and therefore independent of the income level.<sup>19</sup> For the *per-capita income of the retirees* I obtain,

$$\frac{\partial (I^P/N_t^P)}{\partial (P^H/P^L)} = \frac{r'}{N_t^P} (K_{t-1}^Y + (1 + 2r) S_{t-1}) .$$

The retirees own just the factor that wins from trade. This means that they are just benefiting from trade. The higher the price variations—and therefore the increase in  $r$ —, the higher will turn out their benefits. Since the young are just distributing their income between two periods and do not lose it, they can choose their favorite saving deposit according to their time preference. Hence, future benefits through trade lead to lower savings in present. Increased consumption expenditures and a decreasing opposition against trade liberalizations may result. An interesting political implication is arising: Capital-abundant countries with a fully funded pension system will pursue trade with labor-abundant, low-wage-countries, especially if there is a declining, aging population where retirees are in the majority.

A further question is how overall national income is affected through trade. Overall national income will increase if there is a change from a PAYG to a fully funded pension system. This is an important insight since capital accumulation is lower in a PAYG pension system compared to other pension systems (Siebert 1997).<sup>20</sup>

## 5 Change of Pension System

In this section it is analyzed, how trade liberalization with low-wage countries affects a change of the pension system. In order not to discriminate against the retirees of this period, a lump-sum tax is introduced (only in this period). The tax revenue will be then distributed to the retirees according to their contributions to the pension system in the previous period.<sup>21</sup>

---

<sup>19</sup>see Appendix A.1

<sup>20</sup>see Appendix A.2

<sup>21</sup>The claims of the retirees result from the so called *inter-generation contract*. The first, introducing, generation was given a gift, because they got pension payments although they did not contribute to this system. Furthermore, each generation who paid contributions acquired claims against the next one. The resulting pension claims are therefore often known as *implicit public debt*. So a tax is needed to amortize this debt. For further discussion about resulting problems see Sinn (1999).

For simplicity the rate of time preference is assumed equal to zero. Also assume that

$$P_{t+1}^L < P_t^L, P_{t+1}^H > P_t^H \text{ and therefore}$$

$$w_t (P_t^H / P_t^L) > w_{t+1} (P_{t+1}^H / P_{t+1}^L) \text{ and } r_t (P_t^H / P_t^L) < r_{t+1} (P_{t+1}^H / P_{t+1}^L).$$

I compare the life income—income in this period *plus* income in the next period—of the young when (i) there is no change in the pension system, with (ii) the situation that would prevail, when a change from the PAYG to the fully funded pension system is implemented.

(i) The life income without a system change is calculated from (1), (9), and (10),

$$\begin{aligned} I_{\text{Life}}^{\text{no change}} &= I_t^{Y, \text{PAYG}} + I_{t+1}^{P, \text{PAYG}} = (1 - c) w_t N_t^Y + r_t K_t^Y + c w_{t+1} N_{t+1}^Y + r_{t+1} K_{t+1}^P = \\ &= [w_t (1 - c) + c w_{t+1} (1 + n_t)] N_t^Y + [r_t + r_{t+1}] K_t^Y. \end{aligned} \quad (11)$$

In a pay-as-you-go pension system the capital stock remains unchanged (Siebert 1997 and also figure 2, p. 3), therefore  $K_t^Y = K_{t+1}^P$ .

(ii) Now let  $T$  denote the explicit tax—in this case a *lump-sum-tax*—, that could be calculated from the implicit public debt which is used to pay the claims of the retirees in this period (Sinn 1999). The Life income in case of a system change is then calculated from (3), (4), (9), and (10),

$$\begin{aligned} I_{\text{Life}}^{\text{change}} &= I_t^{Y, \text{change}} + I_{t+1}^{P, \text{FF}} = w_t N_t^Y + r_t K_t^Y - S_t - T + r_{t+1} (K_t^Y + (1 + r_{t+1}) S_t) = \\ &= w_t N_t^Y - T + [r_t + r_{t+1}] K_t^Y + [r_{t+1} (1 + r_{t+1}) - 1] S_t. \end{aligned} \quad (12)$$

Under which conditions is a system change advantageous—in this case (12) should be larger than (11)? After simplifying and summarizing following inequality results,

$$c N_t^Y [w_t - w_{t+1} (1 + n_t)] + [r_{t+1} (1 + r_{t+1}) - 1] S_t \geq T. \quad (13)$$

The higher the population growth rate, the more it is likely that the left part of the inequality is smaller than  $T$ .<sup>22</sup> However, the higher the induced price change, the higher the probability that the left part will be higher. The second term on the left side is positive, because of the increased

<sup>22</sup>In Germany, according to a recent report by the United Nations (2005), there is a negative population growth rate so the left side should be higher than  $T$ .

rental rate of tomorrow. Generally the well-known conclusion that a change from a PAYG to a fully funded pension system is advantageous if there is a negative population growth, results. This conclusion is now extended by the argument that a relative price decrease of the labor-intensive good or a price increase in the capital-intensive good makes a change more attractive. Respectively the implicit public debt may be amortized more easily.

In the last step the lump-sum-tax is made endogenous.  $T$  should be chosen such that all retirees of period  $t$  will receive their claims without being disadvantaged if the PAYG pension system is maintained. To ensure this, the condition  $T = cwN$  must hold.<sup>23</sup> Therefore I get

$$\underbrace{[r_{t+1}(1+r_{t+1})-1]S_t}_A - \underbrace{cw_{t+1}N_t^Y(1+n_t)}_B \geq 0 \quad (14)$$

The previously derived condition is valid. The higher the population growth rate, the less it is advantageous to change the pension system from a PAYG to a fully funded regime. The higher the new relative price of the labor-intensive good, the lower is the wage of labor and the more a change is advantageous. Be sure to get the following insights:

**B** will be lower if there is trade with low-wage-countries (there are lower wages of labor because of a higher relative price of the capital-intensive good  $H$ ). Note that only the wage of the second period, after the removal of trade barriers, is relevant.

**A** will be higher, because the rent of capital in the second period will increase through trade liberalizations, here again only period  $t + 1$  is relevant.

## 6 Concluding Remarks

As the previous sections showed several more or less extreme shocks may change the factor endowment of Home. It may happen that the endowment point leaves the *cone of diversification* and therefore prognoses of the HOS-model are wrong. This problem is shown in the Lerner-Diagram in figure 3.  $E^{\text{PAYG}}$  is the factor endowment point of an economy with a pay-as-you-go pension system. Now two *shocks* occur. First, a change to a fully funded pension system is decided. This will boost the capital stock of this country to the new endowment point  $E^{\text{FF}}$ . Finally an (exogenous) demographic change reduces the population growth below zero, the

<sup>23</sup>Because the capital stock of the retirees remains unchanged, this source of income persists further on.

population declines, and the new endowment point is  $E^{n < 0}$ . As you will notice each of these shocks increased the relative capital endowment.<sup>24</sup> At the same time another effect takes place: the vanishing trade barriers with the labor-abundant Foreign leads to a decrease in  $P^L$ . To maintain the profit-maximizing- and zero-profit-conditions, the *cone* (area between the dashed lines) has to rotate to the right (dotted lines). It may happen that the above described effects were indeed not extreme enough to push the endowment point outside the *cone*, but the price shock is high enough to do that. To sum up, if one of these shocks is too extreme, the country may leave the *cone* so that many forecasts of the Heckscher-Ohlin-Samuelson-model won't occur.

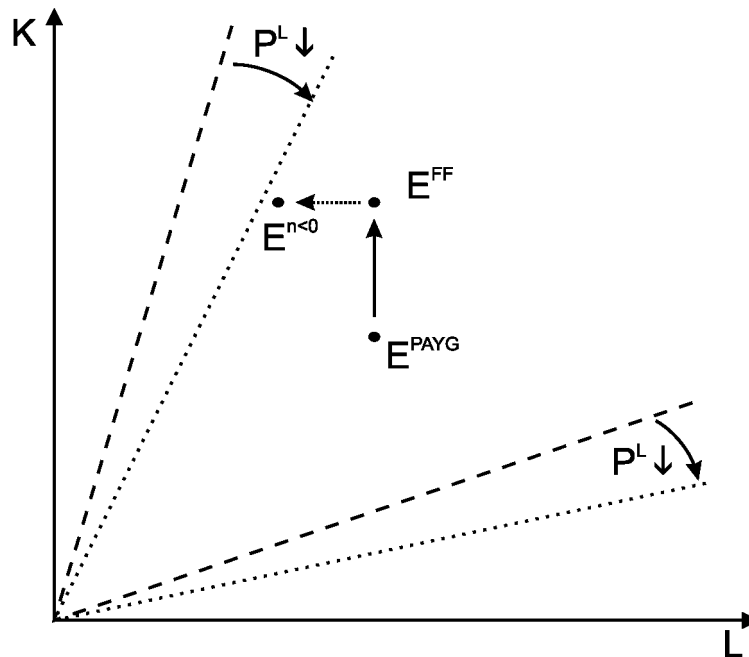
Another aspect of those shocks, which should be mentioned, is the change in the trade pattern. As Home becomes more and more capital-abundant it will concentrate more on the production of the capital-intensive High-Tech good. The price change enforces this effect. If Home leaves the cone as a consequence of the shocks it will completely specialize in the production of the High-Tech good. Accordingly to the assumed production functions this will lead to less or more severe consequences for wages of labor and capital. A quite extreme case was analyzed by Leamer (1998). He assumed *Leontieff*-production functions which would lead in the considered case to a positive maximal wage of  $w_0$  dependent on the position of the unit-value isoquant and more surprisingly to a capital rent of 0.

This model assumed that the young generation owns labor as well as capital, whereas the retirees own capital and/or labor according to the actual pension system. In the case of *intergenerational* redistribution (PAYG pension system) according to the contribution rate, one age cohort will win from increased trade, whereas the other one will lose. However, in the case of *intertemporal* redistribution (fully funded pension system) the young may win or lose from trade, but the retirees will always win from trade independent of the level of savings deposits but correlative to their relative capital endowment. Therefore the classical redistribution conflict between labor and capital may change to a generational conflict between the young and the retired generation. Especially in the fully funded pension system the retirees are clear winners from trade liberalizations since they obtain the winning factor.<sup>25</sup> The change from a PAYG

<sup>24</sup>Graphically the slope of the ray from the origin to the endowment point raises.

<sup>25</sup>The analysis is concentrated on a capital-abundant country. In a labor-abundant country retirees will *ceteris paribus* be clear losers in this model framework.

Figure 3: Effects in the Lerner-Diagram



Source: Model described in text

to a fully funded system during a period of vanishing trade barriers may lead to intergenerational redistributions if the positive aspects of trade are omitted in the planning of the system changeover.

However, these results emerged from a simple two-period model with an unchanging capital stock in the PAYG pension system. If a dynamic model with more periods and capital accumulation is considered other results may occur. The purpose of this paper was mainly to show that there exists a relationship between trade and the pension system. On the one hand, as shown in the literature, trade will redistribute among factors and in this case also among generations. On the other hand the choice of the pension system determines partly the factor endowment of a country and therefore the trade pattern. A country with fully funded pension system will concentrate more on the production of capital-intensive goods than one with a PAYG pension system. Another important aspect analyzed in this paper is the connection between the existing pension system and the attitude towards trade liberalizations. As it was derived in section 4 in a highly redistributive PAYG pension system the young generation may accept increased trade and the retirees may disagree. In a fully funded pension system retiree always will benefit from trade liberalizations and even myopic young persons may accept trade. If the young are

long term oriented and prefer future consumption at least as much as present consumption, they surely may vote for trade liberalizations if their home country is capital-abundant, although income inequality between the young and the retirees will rise.

The quite progressive development of trade relationships, especially with low-wage labor-abundant countries will lead to more price reductions of labor-intensive goods. This could be a chance for a changeover from the widely, but under demographic aspects in many countries inefficient PAYG to a fully funded, or partly fully funded, pension system. However, changeover costs may be reduced faster. Furthermore, a fully funded pension system will also lead to a higher welfare level respectively to more national income, because there is a higher capital stock in period  $t + 1$  compared to the previous period. Furthermore, this factor gains from trade—as long as the endowment point remains inside the *cone of diversification*. A secondary aspect emerges. In a fully funded pension system combined with HOS-trade the redistribution conflict may change to a generational conflict, since the young generation will mainly own labor and the retired generation will mainly own capital.

## A Appendix

### A.1 Percentage Saving

The case of percentage savings leads to no further insights. Following essential equalities are given:

$$I_t^Y = (1 - s_t) [w_t N_t^Y + r_t K_t^Y] \quad (3a)$$

$$I_t^P = r_t K_{t-1}^Y + r_t (1 + r_t) s_{t-1} [w_{t-1} N_{t-1}^Y + r_{t-1} K_{t-1}^Y] \quad (4a)$$

In per-capita terms I get

$$I_t^Y / N_t^Y = (1 - s_t) \left[ w_t + r_t \frac{K_t^Y}{N_t^Y} \right] \text{ and} \quad (7a)$$

$$I_t^P / N_t^P = r_t \frac{K_{t-1}^Y}{N_t^P} + r_t (1 + r_t) s_{t-1} \left[ w_{t-1} + r_{t-1} \frac{K_{t-1}^Y}{N_t^P} \right] \quad (8a)$$

Therefore I can differentiate (7a) and (8a) to obtain

$$\frac{\partial (I_t^Y / N_t^Y)}{\partial (P^H / P^L)} = (1 - s_t) \left[ w' + r' \frac{K_t^Y}{N_t^Y} \right] \text{ and}$$

$$\frac{\partial (I_t^P / N_t^P)}{\partial (P^H / P^L)} = \frac{r'}{N_t^P} \left[ K_{t-1}^Y + (1 + 2r) s_{t-1} \left( w_{t-1} + r_{t-1} \frac{K_{t-1}^Y}{N_t^P} \right) \right]$$

Simple rearranging shows that percentage saving leads to no other conditions as lump-sum saving.

### A.2 Total national income

Total national income under a PAYG pension system adds to  $GDP_t^{\text{PAYG}} = r_t K_t + w_t N_t^Y$  and under a fully funded pension system to  $GDP_t^{\text{FF}} = r_t K_t + w_t N_t^Y + [r_t (1 + r_t) - 1] S$ , for  $S = S_t = S_{t-1}$ . Capital accumulation in a fully funded pension system increases overall income. Trade will boost this positive aspect,

$$\frac{\partial GDP_t^{\text{PAYG}}}{\partial (P^H / P^L)} = r' K_t + w' N_t^Y \quad \text{and} \quad \frac{\partial GDP_t^{\text{FF}}}{\partial (P^H / P^L)} = r' K_t + w' N_t^Y + r' (1 + 2r) S.$$

If you compare both derivatives you see that an economy with a fully funded pension system will benefit more from trade than one with a PAYG pension system.

## References

- BÖRSCH-SUPAN, AXEL (1997): Germany: A Social Security System On The Verge Of Collapse, in: Horst Siebert (ed.), *Redesigning Social Security*, Mohr Siebeck: Tübingen, pp. 129–159.
- BÖRSCH-SUPAN, AXEL, LUDWIG, ALEXANDER AND JOACHIM WINTER (2003): Aging, Pension Reform, And Capital Flows: A Multi-Country Simulation Model, MEA Discussion Paper 28-03, MEA, University of Mannheim.
- BROWNING, EDGAR K. (1975): Why The Social Insurance Budget Is Too Large In A Democracy, *Economic Inquiry*, Vol. XIII, pp. 373–388.
- CIGNO, ALESSANDRO (1993): Intergenerational transfers without altruism, *European Journal of Political Economy* 9, pp. 508–518.
- DEARDORFF, ALAN V. (1987): Trade and Capital Mobility in a World of Diverging Populations, in: Johnson, David Gale and Ronald D. Lee (eds.), *Population Growth & Economic Development: Issues and Evidence*, Madison, Wisconsin, pp. 561–588.
- FELDSTEIN, MARTIN AND CHARLES HORIOKA (1980): Domestic Saving And International Capital Flows, *Economic Journal*, Vol. 90, pp. 314–329.
- FRENCH, KENNETH R. AND JAMES M. POTERBA (1991): Investor diversification and international equity markets, *American Economic Review*, Vol. 81 No. 2, pp. 222–226.
- LEAMER, EDWARD E. (1998): In Search of Stolper-Samuelson Linkages between International Trade and Lower Wages, in: Collins, Susan Margaret (ed.), *Imports, Exports and the American Worker*, The Brookings Institution, Washington, DC, pp. 141–202.
- MCCULLOCH, RACHEL (2005): Protection and Real Wages: The Stolper-Samuelson Theorem, forthcoming in: Szenberg, Michael, Ramrattan, Lall and Aron Gottesman (eds.), *Samuelsonian Economics and the Twenty-First Century*, Oxford: Oxford University Press. url: <http://www.brandeis.edu/~rmccullo/wp/Stolper-Samuelson0405.pdf>
- O'ROURKE, KEVIN H. (2003): Heckscher-Ohlin Theory and Individual Attitudes Towards Globalization, Working Paper 9872, National Bureau of Economic Research.



UNITED NATIONS (2005): World Population Prospects - The 2004 Revision - Highlights.

url: [http://www.un.org/esa/population/publications/WPP2004/2004Highlights\\_finalrevised.pdf](http://www.un.org/esa/population/publications/WPP2004/2004Highlights_finalrevised.pdf)

UNITED NATIONS (2006): World Population Prospects: The 2004 Revision Population Database, url: <http://esa.un.org/unpp/>.

SINN, HANS-WERNER (1999): Pension Reform And Demographic Crisis: Why A Funded System Is Needed And Why It Is Not Needed, Working Paper No. 195, CESifo Working Paper Series, CESifo.

SIEBERT, HORST (1997): Pay-as-You-Go Versus Capital-Funded Pension Systems: The Issues, in: Horst Siebert (ed.), Redesigning Social Security, Mohr Siebeck: Tübingen, pp. 3–33.

WALZ, UWE AND DIETMAR WELLISCH (1998): Why do rich countries prefer free trade over free migration? The role of the modern welfare state, *European Economic Review* 42, pp. 1595–1612.