

**572** LECTURE NOTES IN ECONOMICS  
AND MATHEMATICAL SYSTEMS

Matthias F. Jäkel

# Pensionomics

On the Role of PAYGO  
in Pension Portfolios



Springer

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Matthias F. Jäkel

# Pensionomics

On the Role of PAYGO  
in Pension Portfolios

With 17 Figures  
and 10 Tables

 Springer

Matthias F. Jäkel  
WHU, Otto Beisheim School of Management  
Dresdner Bank Chair of Finance  
Burgplatz 2  
56179 Vallendar  
Germany  
E-mail: mjaekel@whu.edu

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To my parents

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## Foreword

This thesis is the result of my doctoral studies at the Dresdner Bank Chair of Finance at the WHU – Otto Beisheim School of Management. The WHU, a young, private institution and trailblazer in the German educational landscape, played a central role in my academic, professional and personal development. Having completed my undergraduate and graduate studies in this friendly and informal but at the same time encouraging and challenging atmosphere, I was more than happy to continue my studies at the doctoral level in WHU's unique setting.

Yet such an academic enterprise could not take place without the generosity of many selfless people who give hours of their time to listen to, engage with, and improve upon the works of others. Therefore, I want to especially thank my supervisor and mentor Professor Dr. Markus Rudolf for his guidance and support throughout my time at the Dresdener Bank Chair of Finance. Early in my final study year he drew my attention to financial research, and my interest into the subject of demography and finance can also be traced back to my master thesis produced under his supervision. During my time as a doctoral candidate, he provided very helpful instruction and useful advice as well as encouragement and constructive criticism when needed. At the same time he understood to generate a friendly and harmonious environment with sufficient academic freedom for his team of young researchers.

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Last but not least, my greatest appreciation goes to my parents Brigitte and Peter Jäkel for their constant encouragement and total support throughout my academic education and all my life. I dedicate this book to them.

Frankfurt, January 2006

*Matthias Jäkel*

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# Contents

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## Part I The Problem

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<b>1</b>	<b>Global Aging and Pensionomics</b> .....	3
1.1	Global Aging .....	4
1.2	Pension Problem .....	12
1.3	Objective and Synopsis.....	16
<b>2</b>	<b>Methodical Foundation</b> .....	19
2.1	Outline and Requirements .....	19
2.2	Theoretical Background .....	23
2.2.1	Neoclassical Paradigm .....	23
2.2.2	Portfolio Approach .....	27
2.2.3	Asset Pricing .....	31
2.2.4	Production and q-Theory .....	35
2.2.5	Growth Theory .....	37
2.2.6	Public Finance.....	44
2.3	Summary and Survey of Approach.....	46

---

## Part II The Model

---

<b>3</b>	<b>Tradable Human Capital</b> .....	53
3.1	Population and Overview .....	53
3.1.1	Overlapping Generations Framework.....	53
3.1.2	Outline of Model .....	56
3.2	Consumption and Capital Technologies.....	57
3.2.1	Macroeconomic Production Function.....	57
3.2.2	Capital Adjustment Technology .....	59
3.2.3	Price of Real Capital and Q-Ratio .....	61
3.2.4	Real Capital's Rental and Return .....	62
3.2.5	Extreme Cases .....	63



3.2.6	Illustrative Example Economy	65
3.3	Financial Markets Description	66
3.3.1	Real Capital Security	66
3.3.2	Human Capital Security	68
3.3.3	Riskless Security	71
3.3.4	Capital Market and Summary	72
3.3.5	Full Depreciation	73
3.3.6	Illustrative Example Economy	75
3.4	Optimization by Agents	76
3.4.1	Utility Assumptions	76
3.4.2	Budget Constraints	79
3.4.3	Optimal Policies	81
3.4.4	Stochastic Discount Factor	85
3.4.5	Summary of Policies	88
3.4.6	Illustrative Example Economy	88
3.5	Capital Market Equilibrium	90
3.5.1	Aggregating Assumptions	90
3.5.2	Deriving Equilibrium	92
3.5.3	Market Portfolio Weights	96
3.5.4	Returns and Interest Rate	98
3.5.5	SDF Approach	100
3.5.6	Full Depreciation	102
3.5.7	Illustrative Example Economy	104
3.6	General Equilibrium	107
3.6.1	Consumption by Cohorts	107
3.6.2	Investment-Output Ratio	110
3.6.3	Goods Market Equilibrium	114
3.6.4	Full Depreciation	116
3.6.5	Illustrative Example Economy	117
3.7	Summary for Tradable Human Capital	118
<b>4</b>	<b>Replication with PAYGO</b>	<b>121</b>
4.1	Incomplete Markets and Overview	121
4.1.1	First- versus Second-best	121
4.1.2	Outline of Replication	124
4.2	Mimicking Economy	126
4.2.1	Maintained Setting	126
4.2.2	Public Sector	129
4.2.3	Agents' Utility and Budget Constraints	132
4.2.4	Summary of Mimicking Economy	134
4.2.5	Full Depreciation and Numerical Example	134
4.3	Solving the Mimicking Economy	138
4.3.1	Failure of Standard Approaches	139
4.3.2	Aggregation and Capital Market Participation	142
4.3.3	Alternative Characterization	144

4.3.4	Sustainability and Integration . . . . .	146
4.3.5	Full Depreciation and Numerical Example . . . . .	149
4.4	Replicating Tradability . . . . .	150
4.4.1	Replication Set-up . . . . .	150
4.4.2	Solving the Replication . . . . .	152
4.4.3	Analyzing the Solution . . . . .	155
4.4.4	Full Depreciation . . . . .	159
4.4.5	Case of Merton [1983] . . . . .	163
4.4.6	Illustrative Example Economy . . . . .	165
4.5	Summary of Replication . . . . .	167

**Part III The Implications**

<b>5</b>	<b>Discussion and Assessment . . . . .</b>	<b>173</b>
5.1	Overview . . . . .	173
5.2	Analyzing the Framework . . . . .	176
5.2.1	Asset Pricing and Allocation . . . . .	176
5.2.2	National Income . . . . .	181
5.2.3	National Wealth . . . . .	183
5.2.4	Replication with PAYGO . . . . .	190
5.2.5	Growth Theory . . . . .	194
5.2.6	Full Depreciation . . . . .	198
5.2.7	Illustrative Example Economy . . . . .	201
5.2.8	Replication of Illustrative Example Economy . . . . .	203
5.3	Technological Progress . . . . .	206
5.3.1	Stochastic Growth Theory . . . . .	207
5.3.2	Factor Incomes in Cobb-Douglas Case . . . . .	212
5.3.3	Implications for PAYGO . . . . .	216
5.4	Design of PAYGO Schemes . . . . .	219
5.4.1	Risk Diversification . . . . .	219
5.4.2	Earning Points and Indexation . . . . .	226
5.4.3	Replication Framework and Existing PAYGO Schemes . . . . .	231
5.5	Summary of Implications . . . . .	237
<b>6</b>	<b>Conclusion and Further Research . . . . .</b>	<b>241</b>
6.1	The Model and its Implications . . . . .	241
6.2	Outlook on Pensionomics . . . . .	245

**Part IV Appendices**

<b>A</b>	<b>Methodological Foundation . . . . .</b>	<b>253</b>
A.1	Asset Pricing . . . . .	253
A.2	Growth Theory . . . . .	254

<b>B</b>	<b>Tradable Human Capital</b> .....	255
B.1	Optimization by Agents .....	255
B.1.1	Optimization by Middle-aged .....	255
B.1.2	Optimization by Young .....	256
B.1.3	Stochastic Discount Factor .....	258
B.2	Capital Market Equilibrium .....	259
B.2.1	Deriving Equilibrium .....	259
B.2.2	Market Portfolio Weights .....	261
B.3	General Equilibrium .....	263
B.3.1	Consumption .....	263
B.3.2	Investment-Output Ratio .....	264
B.3.3	Full Depreciation .....	269
<b>C</b>	<b>Replication with PAYGO</b> .....	271
C.1	Replicating Tradability .....	271
C.1.1	Derivation of (4.4.14) .....	271
C.1.2	Derivation of Public Sector Parameters .....	272
C.2	Full Depreciation .....	274
C.2.1	Replicating Parameters .....	274
C.2.2	Alternative Derivation .....	276
<b>D</b>	<b>Discussion and Assessment</b> .....	279
D.1	Analyzing the Framework .....	279
D.2	Technological Progress .....	280
D.2.1	Stochastic Growth Theory .....	280
D.2.2	Derivation of Stationary Distribution .....	281
D.2.3	Cobb-Douglas Case .....	282

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**Part V Lists and References**

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<b>List of Tables</b> .....	287
<b>List of Figures</b> .....	289
<b>Symbols and Abbreviations</b> .....	291
<b>References</b> .....	295

**The Problem**

## Global Aging and Pensionomics

### *Alice in Fiscal Land*

One day a girl named Alice fell down a very deep hole near a tree in the park. After lots of adventures and bumping into strange-looking accountants, actuaries, and tax attorneys, Alice finds herself face to face with Tweedledum and Tweedledee, two citizens of different countries in Fiscal Land. The two are having a heated debate about which country has the better fiscal policy:

*Tweedledum: We tax the young \$1,000 each to help the old. But we're debt free.*

*Tweedledee: Well, we also help the old, but we do it by borrowing \$1,000 each from the young. And we tax the old \$100 each to pay the interest on the debt.*

*Tweedledum: Well, you have debt. That's bad.*

*Tweedledee: Well, you tax young people. That's worse.*

*Tweedledum: Debt erodes one's moral fiber.*

*Tweedledee: Taxing the young to support the old is exploitive.*

Back and forth, back and forth, the two argue, hour after hour, until Alice, who has a Ph.D. in linguistics, screams: "Your countries have exactly the same fiscal policy!" "No way," they both reply. "His has debt, and mine doesn't," says Tweedledum. "And his taxes the young and mine taxes the old," yells Tweedledee. "Of course you're right, but actually you're wrong." Alice says as she shows them table [below]. "Look," Alice says, "in both countries, the young hand over \$1,000 each to the government, and the old receive, on balance \$1,000 from the government. In one country, the government takes \$1,000 from the young and calls it a tax. In the other, it calls it borrowing. In one country, the government hands \$1,000 to the old and calls it a transfer payment. In the other, government hands \$1,000 to the old and calls it a return plus interest of \$1,100 less a tax of \$100. So you have the same policies; you're just calling them different things."

The two Tweedles stare dumbfounded at Alice and then exclaim: "Oh, we get it. You're an economist. That's why we don't understand a word you're saying." "Trust me," says Alice. "I'm nothing of the kind. This is just a matter of logic. In your country, Tweedledum, young people get back in old age what they pay in taxes when young, but they don't earn any interest. And in your country, Tweedledee, young people get back in old age with interest what they paid in principal when young, but then the interest is taken away from them." "You really are an economist," shout the Tweedles. "You interrupt a critically important policy debate with some cockamamie theory that has no connection to reality. How about getting lost?"

At this, Alice breaks down in tears and runs headlong into the Queen of Hearts, who promptly arrests her for promoting tax evasion.

Kotlikoff and Burns [2004]: "The Coming Generational Storm", p. 74-76

*Deficit Delusion in Fiscal Land*

<i>Transaction</i>	<i>Tweedledum's Country</i>	<i>Tweedledee's Country</i>
<i>Net payment when young</i>	<i>\$1,000</i>	<i>\$1,000</i>
<i>Net receipt when old</i>	<i>\$1,000</i>	<i>\$1,000</i>
<i>Description of net payment when young</i>	<i>A \$1,000 tax payment</i>	<i>Purchase of a \$1,000 government bond</i>
<i>Description of net receipt when old</i>	<i>A transfer payment</i>	<i>Payment of \$1,100 in principal and interest less a \$100 tax</i>

*Pensionomics*

In the course of the global demographic change, population aging will be one of the most important and radical changes in human history. While this is not a new insight most of the public debate and scientific research focussed on the direct socio-political consequences only, especially on the sustainability of fiscal regimes and pay-as-you-go pension systems. Yet, the demographic change will fundamentally alter the understanding of the economy as it affects all of its central markets – those for human labor, for goods and services as well as for financial capital. Facing this, the question of how to effectively and efficiently deliver retirement income will be one of the most eminent problems, not only for the Tweedles. For answering it an in-depth combination of pension finance and economics is required: a step into Pensionomics.

**1.1 Global Aging**

Century-long population growth has given rise to the modern societies and science has helped to generate and to understand the standard of living now enjoyed. Economics has emerged as one of the sciences focusing on managing scarcity – of consumable goods, physical capital or real property. Now an unprecedented change is taking place and will ultimately alter the focus onto scarcity of *human beings*. A short retrospection of the past demographic trend, its impact on economic development and the scientific understanding of it builds some understanding for the upcoming seismic shift in its full breadth and depth.

### *History of Population Trends*

Assessing the consequences of population change on the pace and process of economic growth is one of the oldest topics in the economic literature. The debate began with Malthus [1798] and his proposition that population would grow at a geometric rate while food supply increases at an arithmetic one, which eventually overcomes the world's ability to feed itself and results in widespread starvation. His view of economics as a dismal science can only be understood based on the historic development of global population.

During their first 100,000 years homo sapiens increased their population at an extremely slow rate. Only the discovery of agriculture at about 9000 B.C. made possible a higher population growth, allowed the creation of cities and eventually led to the first great civilizations in Mesopotamia, India, China and ancient Latin America. The moderate increase continued until around A.D. 600 when a millennium of population cycles with periodic pandemics of diseases like the black plague restrained further expansion. Then, at about 1700, the Agricultural Revolution with its enormous advances in food production permitted the population virtually to explode.<sup>1</sup> Global population started a vast increase from about 500 million in 1700 to more than 6 billion in 2000 and experienced dramatic social changes like the Industrial Revolution and the French Revolution. The start of modern economics as a discipline of its own by Smith's [1776] discussion of political economy must be seen in this context.

Mankind escaped the Malthusian doom, because Malthus failed to predict these agricultural and economic advances. His pessimist view was based on the assumption that food supplies were directly proportionate to the amount of land available. Though this had been historically true, the relationship changed exactly when Malthus extrapolated the empirical evidence to make his predictions: the Agricultural Revolution had just enabled English farmers to produce more food from the same area of land. So Malthus observed the resulting faster population growth but contrasted it with the ancient development in food production. In the long run, he was wrong, too, because the population change he considered geometrical turned out to be sigmoidal. Yet, the leveling-out of this trend takes more than two centuries and is not only driven by the birth rate.

The resulting change of population has been coined *Demographic Transition* based on an interpretation of Thompson [1929].<sup>2</sup> While the more developed countries have been experiencing this transition over the past 200 or so years, less developed countries only began it in the 20th century, yet at a considerably faster rate of change. The theoretic model for the Demographic Transition

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<sup>1</sup>This mostly follows Fogel and Costa [1997], whose Table 1 highlights the dramatic growth in population started in 1700. Currais [2000] and Weir [1987] provide deeper understanding on the history of population economics.

<sup>2</sup>The theory of demographic transition has been substantially formed by Notestein [1945] and enlarged by Blacker [1947].

is based on changes in birth and death rates which typically can be categorized in four stages: The first characterizes the pre-modern times before the Agricultural Revolution with balancing birth and death rates at very high levels. This was the Malthusian stalemate with hardly any change in population. Stage two sees a skyrocketing rise in population caused by a decline in the mortality, while fertility remains still high out of tradition and practice. The decline in the death rate, particularly in childhood, is due to the improvements in food supply and to the significant progress in public health – less based on medical breakthroughs than based on advances in water supply, sewage, food handling, and general personal hygiene. The result is another key characteristic of the second stage: the age structure of the population becomes increasingly youthful creating the now famous age pyramid. However, industrialization and urbanization altered the traditional values placed upon fertility and changed the value of children in society. This gives the third stage of the Demographic Transition that moves the population towards stability through a decline in the birth rate. The ideas of the New Home Economics replacing the Malthusian perspective help to understand this change in fertility: starting with Becker [1960] economists view parenthood as driven by the consumption-like pleasure of having children and the provision of future material benefit to the family unit. The parental demand for children depends hence on family income, how parents value their time and on quality-like characteristics of children.<sup>3</sup> Yet, even at the end of the third stage, when fertility has dropped to the level of replacement, population growth continues for a while due to population momentum, i.e. a relatively high concentration of people in the childbearing years. Finally, the Demographic Transition ends with stage four, which is again characterized by stability. However, frequently the fertility rate falls well below the replacement level and population decline sets in rapidly.

While many less developed countries are still in the second stage, most industrialized countries would have actually finished the transition in the late 20th century. However, following World War II Europe, North America and to a lesser extent also Japan experienced a massive increase in fertility. This *Baby Boom* lasted until the mid 1960s when birth rates dropped back. While conventional wisdom links the Baby Boom to the general optimism following the soldiers' return from World War II and the prevailing economic boom, a new explanation of Greenwood et al. [2005] accredits it to the invention of labor-saving household products and management techniques. Since the end

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<sup>3</sup>Other major contributions are Easterlin [1968], Becker and Lewi [1973], and Becker [1991]. Willis [1987] provides a summary on New Home Economics. The formation of “quality” children, i.e. qualified workers, gave rise to the emphasis on human capital *formation*; see Schultz [1961, 1963, 1974], Becker [1962, 1993], or Becker and Tomes [1986]. Barro and Becker [1989], Becker et al. [1990], Rosenzweig [1990] and others linked this to economic growth. As will be argued later the view of investment in human capital in the sense of *forming* qualified workers is *not* addressed here.



of the Baby Boom, fertility rates have not only dropped to pre-boom levels, but also continued a decline to sub-replacement levels.

In the early second half of the 20th century, a new concern emerged as developing countries experienced exceptionally high population growth rates based on boom-like fertility and declining mortality. As it was unclear whether the predictable fertility decline a la Demographic Transition would be fast enough to avoid potentially deteriorating effects on economic progress and the environment, the pessimistic Malthusianism reappeared: the famous study for the Club of Rome by Meadows et al. [1972, 1974] predicted uncontrollable mass starvation again based on extrapolation of observed trends – just like Malthus [1798]. Though Asian countries rather succeeded with the implementation of the recommended birth controls, concerns on the Asian population growth continued.<sup>4</sup> Yet, again agricultural and technological advances helped to avoid the doom.

### *Future Population Trend*

Given this understanding of the long-term trend, the current outlook on the global population is hardly surprising. It is deeply driven by changes due to the Demographic Transition. As illustrated in Table 1.1 the world is expected to have 6.5 billion inhabitants by mid 2005. Despite the declining fertility levels projected over 2005-50, most forecasters see a peak of world population at about 9.1 billion.<sup>5</sup>

The reason for this leveling-out is the sharp fall in fertility in course of the Demographic Transition. As seen in Table 1.1, women in *all* regions have now less children than in the 1970s and this decline is expected to continue. For China its one-child policy has accelerated the fertility decline so much that its fertility is estimated at 1.7 children per woman during 2000-05 – far below the 2.1 replacement level. The table gives also data for the other two main drivers of population: mortality and immigration. Global life expectancy at birth – risen from 46 years in 1950-55 to 65 years in 2000-05 – is expected to keep on rising and to reach 75 years in 2045-50. Since the movement of people across international boundaries is very often a response to changing socioeconomic, political and environmental forces, international migration is subject to a great volatility and the component of population change most difficult to define, measure and estimate. Still, the United Nations project a net number of 98 million international migrants to more developed regions for the period 2005-50 – an average of 2.2 million annually.<sup>6</sup>

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<sup>4</sup>See for instance Brown [1992].

<sup>5</sup>Figures are based on United Nations [2004a, p. 3] and United Nations [2005a, p. 6]. Other international sources on population forecasts are United Nations [1999], Donaldson [1999], Haupt and Kane [2004] or U.S. Census Bureau [2004]. Pötzsch and Sommer [2003] focuses on Germany and Day [1996] on the United States.

<sup>6</sup>For details on all aspects of population projections see United Nations [2005a,b,c,d], where all the demographic figures are taken from.

**Table 1.1.** World population prospects

	Population (millions)			Life expectancy at birth	
	1975	2005	2050	2000 – 05	2045 – 50
World	4,074	6,465	9,076	64.7	74.7
More developed regions	1,047	1,211	1,236	74.6	81.7
Less developed regions	3,027	5,253	7,840	62.8	73.6
Africa	416	906	1,937	48.8	65.3
Asia	2,395	3,905	5,217	67.0	77.1
Europe	676	728	653	73.3	80.4
Latin America	322	561	783	71.0	79.4
Northern America	243	331	438	77.4	82.6
Oceania	21	33	48	74.0	81.2
	Total fertility (children per woman)			Net immigration (thousands p.a.)	
	1970 – 75	2000 – 05	2045 – 50	2000 – 10	2040 – 50
World	4.49	2.65	2.05	n.m.	n.m.
More developed regions	2.12	1.56	1.84	2,462	2,158
Less developed regions	5.44	2.90	2.07	-2,462	-2,158
Africa	6.72	4.97	2.52	-410	-322
Asia	5.08	2.47	1.91	-1,244	-1,204
Europe	2.16	1.40	1.83	937	699
Latin America	5.05	2.55	1.86	-740	-567
Northern America	2.01	1.99	1.85	1,360	1,300
Oceania	3.23	2.32	1.92	98	94

*Remarks:* The table gives historic data and projections on the global population and its driving demographic variables. Latin America includes the Caribbean; see United Nations [2005*a*, pp. 153-155] for a description of the areas and regions. Medium-variant is used for 2050-projections.

*Source:* United Nations [2005*a*, Tables I-1, II-1, III-1, IV-1].

For the developed world, this level of net migration will mostly offset the expected excess of deaths over births during 2005-50, which itself amounts to a loss of 73 million people. On the other hand, the 98 million emigrants represent hardly less than 4% of expected population growth for the developing world. Already during 2000-05, net migration in almost thirty countries either prevented population decline or doubled at least the natural contribution to population growth. Among these countries are Austria, Canada, Denmark, Germany, Italy, Portugal, Spain, Sweden, and the United Kingdom. The United States of America, Germany and Canada are projected to be the three major net receivers of international migrants with annually averages of 1.1 million, 204,000 and 201,000, respectively. Still, for more than 50 countries, including Germany, Italy, Japan, the Baltic States and most of the members of the Commonwealth of Independent States, national population is expected to be lower in 2050 than in 2005.

The direct consequence of these trends is population *aging*, whereby the share of older persons in a population increases relative to that of younger persons. But global aging is not only due to the decline in fertility but also driven by the increases in life expectancy. Globally, the number of persons aged 65 years or over is expected almost to triple, increasing from 475 million in 2005 to nearly 1.5 billion by 2050. Even more pronounced is the expected increase in the number of the oldest-old, i.e. persons aged 80 years or over: from 86 million in 2005 to 394 million in 2050.

Figure 1.1 illustrates the aging effect for the six major world regions. Asia has, of course, the most old people in absolute numbers. The *old-age dependency ratio* is the most widely used measure to correct for this size effect describing a population's demographic composition with respect to age. It is the number of persons aged 65 or older per one hundred persons of age 15 to 64.<sup>7</sup>

Although current regional differences in the old-age dependency ratio are expected to persist well into the next 50 years, all six major areas will experience remarkable growth in this ratio over the next half-century: the world's highest old-age dependency ratio of Europe will almost triple in the next 50 years. Based on the projections of the United Nations [2004*b*, 2005*a*], the ratios of Asia and Latin America will more than triple, those of Northern America and Oceania almost double and even Africa's ratio increases by two thirds. While the world's aggregate dependency had increased only from 9.6 in 1950 to 11.4 in 2005, it is expected to reach 25.4 in 2050. In developed countries the elderly population has already surpassed the number of persons aged 14 or less and

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<sup>7</sup>Other definitions of the ratio, sometimes also referred to as old-age ratio, include the population of ages between 15 and 59 only. In this sense the figures here are rather conservative. The old-age dependency ratio and the youth dependency ratio – persons under 15 per persons aged 15-64 – sum to the total dependency ratio. These indicators give insight into the amount of people of non-working age compared to the amount of people of working-age. Another measure for the pure aging effect is the age-index as the number of persons of 60 years or older per hundred persons under age 15. For more definitions of indicators see United Nations [2005*a*, p. 41-42].

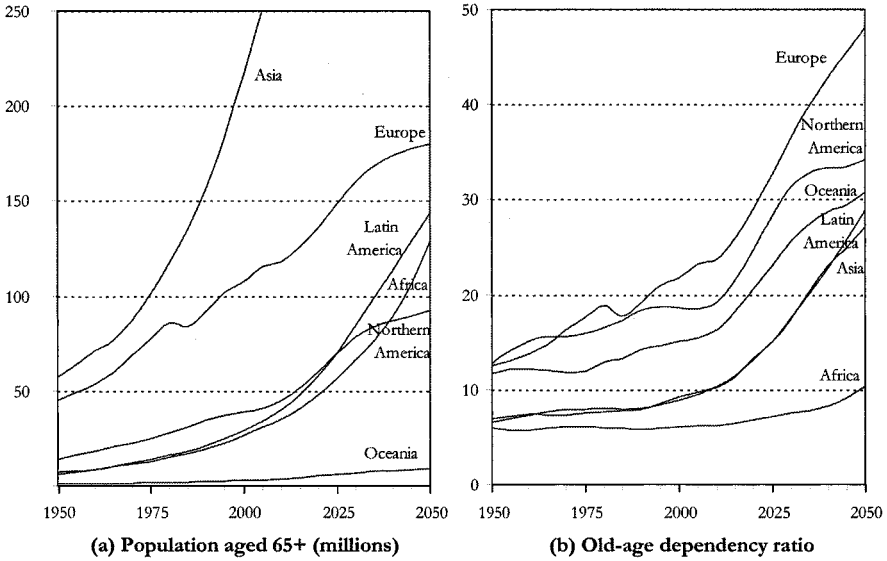


Fig. 1.1. Global aging

*Remarks:* Graph (a) shows the number of people aged 65 and older for the six major world areas. Asia will exceed 900 millions in 2050. Graph (b) depicts the corresponding old-age dependency ratio, that is the number of persons aged 65+ per one hundred persons of age 15 to 64. Latin America includes the Caribbean. *Data Source:* United Nations [2004b, 2005a], Medium-variant of population database.

by 2050 there will be even 2 elderly persons for every child. While today only 11 developed countries have a median age above 40 years, by 2050, there will be 90 countries in that group. For the world, the median age is projected to increase by about 10 years over the next half century, having only risen by about 3 years in the past 50 years. Population aging – in developed countries already a pervasive reality – is also inevitable in the developing world and will occur there considerably faster. Aging is thus not limited to any region or country, but a truly *global phenomenon*.<sup>8</sup>

The Demographic Transition as demography’s mainstream theory perfectly explains the observed changes and is the theoretical foundation for these projections: due to the social and economic development, mortality declines globally, resulting in a higher life expectancy as seen in Fig. 1.1. Fertility

<sup>8</sup>Further indicators of past and future aging can be found in United Nations [2001] or Kinsella and Velkoff [2001], but also general population forecast like United Nations [2005a] emphasize this issue. Birg [2003] provides an overview over the subject focussing on Europe and Germany.

follows this trend, yet with a time lag, inducing a substantial population growth. Whereas developed countries took centuries for this process, some rapidly developing countries like the Economic Tigers are now transforming in mere decades. Hence, the more developed regions – in particular Europe – have been leading population aging, but all regions will experience the same changes. While industrialized countries, above all the United States, managed to compensate the falling birth rates with immigration from less developed regions, the actual aging will become more noticeable in the future: it would not only require ever greater numbers of immigrants, but the situation will also be aggravated as the baby-boomers age. While so far this demographic extra-effect helped to reduce the old-age dependency ratio based on disproportionately many persons of age 15 to 64, the result of the Baby Boom will drastically deteriorate the old-age dependency ratio in the period 2010-25, when the large cohorts not only leave the working age but also enter the group of 65+. This explains the clear steepening of Europe's line for the old-age dependency ratio in Fig. 1.1.

In accordance with the Demographic Transition proposition, the phase of highest population growth is over. The increase in world population, which slowly started in the 17<sup>th</sup> and 18<sup>th</sup> centuries and rose dramatically in course of the 20<sup>th</sup> century, reached a peak at 2% per year in 1965-70. While the studies of Meadows et al. [1972, 1974] extrapolated this trend, the actual growth rate of the world population has declined since then, reaching 1.2% per annum in 2000-05, and is expected to drop further to an annually 0.4% by 2045-50. The sigmoidal population trend is leveling-out after 350 years.

Concerning future fertility and mortality, two more concepts must be mentioned, which currently influence demographic research. Among population scholars the concept of a “Second Demographic Transition” has become an important additional explanation concerning the demographic change in European societies. This theory stresses the importance of ideational changes for altering demographic behaviors such as single living, pre- and post-marital cohabitation, delayed fertility or high prevalence of non-marital fertility.<sup>9</sup> Concerning mortality patterns, the process of the “Technophysio Evolution” has been introduced by Fogel [1994] as a synergism between technological and physiological improvements leading to greatly improved robustness and capacity of the human physiology. Though this process started with the Agricultural Revolution and has since then increased body size by over 50%, it is still going on and hence relevant for forecasting longevity and morbidity.<sup>10</sup> Similar ideational changes on a global level or continued physiological advance will only aggravate the phenomenon of global aging.

<sup>9</sup>The concept of the Second Demographic Transition has been introduced by Lesthaeghe and van de Kaa [1986]. See also Lesthaeghe and Neels [2002] and Lesthaeghe and Surkyn [2004].

<sup>10</sup>See also Fogel [1997] and Fogel and Costa [1997]. Fogel [2003] relates the changes of the Technophysio Evolution to health care costs and intergenerational conflicts. A summary of the longevity issue is found in Vaupel [1998].

To summarize, within the next 50 years a three centuries old trend of population growth and average rejuvenating will revert globally. For the industrialized countries this global aging is intensified by the long-term consequences of the post-war Baby Boom.

## 1.2 Pension Problem

Unlike other predictions about the future, global aging is not a mere hypothesis. As its approximate timing and magnitude are already locked in, it is like a revolution sure to happen. Yet, it is important to see population aging as a *human success story* in the first place: the triumph of public health, medical advancements, and economic development over diseases and injuries that limited human life expectancy for millennia. However, one must also acknowledge that the phenomenon of aging will bring dramatic consequences: global aging will restructure economies, reshape families, redefine politics and even rearrange the geopolitical order of the next century. The focus of this contribution will be only on the economic development and on the challenges which aging poses on the way of providing and sustaining retirement income for the elderly. Though this particular question is certainly not the only pressure global aging poses, it is definitely one of the most urgent ones.

### *Economic Challenges of Aging*

It is widely agreed that global aging has a deep impact on macroeconomic development. The main channels, through which aging affects the economy, are changes in the labor force, the effect on public finances from increased pressure on public health and pension expenditure, and influences on private saving behavior as a result of life-cycle effects. All of these must – at least – be considered in a thorough analysis. Furthermore, as the overall population declines in the coming decades, so will the number of consumers and producers. There will be fewer persons in the household-forming years leading to overcapacity and falling returns on investment in such key sectors as construction, real estate and durable goods. Many industries will lose the possibility to reach economies of scale.<sup>11</sup>

While for many decades demographics and labor force participation trends have provided a favorable economic environment in many developed countries, global aging will start an era of tight labor markets. Though it is hardly

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<sup>11</sup>Detailed assessments of the macroeconomic and financial implications of aging populations can be found in Group of Ten [1998], McMorrow and Roeger [1999], OECD [1998] or Turner et al. [1998]; OECD [2000]. The Center for Strategic and International Studies has established an age-vulnerability index for various economies; see Jackson and Howe [2003] and Jackson [2003] for Germany. England [2002a,b, 2005] provides good summaries on the impact of aging on macroeconomics, financial markets and on the special role of China. China's pronounced aging problem is also the focus of Cheng [2003].

imaginable given present problems on the labor market, the workforce in much of continental Europe and Japan is projected to be contracting by roughly 1% annually by 2010. In the past, the fraction of the population at work had *constantly* been growing, even though generous retirements rules allowed for a dramatic fall in the number of individual years spent in work. Unless the future decline in the workforce is offset by increases in labor productivity and the effective supply and utilization of it, the growth of material living standards will fall. Of course, this concern is based on the assumption that the elderly will hardly contribute to the economy in the future. Yet, governments may respond with policies designed to expand the labor supply by encouraging more citizens to work and by encouraging those who are already employed to work more and longer in their lifetime. However, in most countries such policies, which could soften the economic consequences of the increasing dependency-ratio, have to overcome deep-rooted social expectations — about early retirement, shorter work weeks or the role of women. Moreover, these policies are unlikely to be effective unless governments reform public retirement systems first, whose rising costs present a big disincentive for work. Only sluggishly are governments beginning to accept that *substantial* reform is necessary to ensure the viability of the public systems for social security.

When German Chancellor Otto von Bismarck established the world's first national old age provision plan in 1889, he designed it as contributory "social insurance": by relating benefits to contributions made, this pension plan had elements of an insurance for the participating workers and was not just a pure redistribution scheme. While the basic principle has remained essentially the same, economic circumstances have changed dramatically: in the beginnings of public pension schemes the state promised a modest benefit to a tiny minority of workers lucky enough to survive to the age of 70. Today, the vast majority of Germans can look forward to a retirement lasting a third or more of their adult lives. Worldwide numerous countries have copied the German system. Above all, after the World War II public pensions have become the financial lifeline of the elderly in many societies. Old-age pension schemes are now social institutions in many – if not most – countries throughout the world. The goal of most public old-age pension schemes is to provide all qualifying individuals with an income stream during their later years. In most developed countries more than 90% of the labor force are now covered by mandatory old-age pension plans. The arrangements are commonly referred to as "pay-as-you-go" or PAYGO systems, insofar as current revenues – contributions from current workers – are used to finance the pension payments of people who have already retired from the labor force. Like the German archetype, most PAYGO systems were initially based on a small number of pensioners relative to a large number of contributing workers and could hence promise generous benefits. As systems matured and the Demographic Transition became ever more noticeable, ratios of pensioners to contributors grew. In some countries the PAYGO systems proved to be unsustainable, particularly during periods of economic stagnation. While part of the measures taken by politics –

or at least considered – include increases in contribution rates, restructuring or reducing of benefits, and raising the standard age of retirement, a major result of the problems was the development of private pension systems to complement the public PAYGO ones.<sup>12</sup>

### *Crumbling Pillars of Old Age*

In particular the landmark report of the World Bank [1994] advocated such a mix of systems. Therein the World Bank identified three main roles of pension systems: poverty relief, consumption smoothing, and redistribution from lifetime rich to those at risk of old-age poverty. The bank concluded that the challenges of global aging could be met best by combining the above mentioned public pay-as-you-go system with a privately managed mandatory saving accounts and voluntary retirement savings. This was the origin of the “multi-pillar” pension model. After many countries in Latin America, Europe and central Asia adopted these proposals, the bank supplements the initial three systems in its new report by Holzmann and Hinz [2005] by two more pillars: a tax-financed safety net and non-financial means such as family support or access to health care. Furthermore, it establishes the goals that pension schemes should achieve: they are supposed to provide adequate, affordable, sustainable, and robust benefits. Adequacy refers to both the absolute level as well as the relative lifetime level of retirement income that the pension system will provide. In order to prevent negative consequences for individual economic lifetime opportunities and general economic growth, pension schemes must obey individual and societal financing limits and be affordable. Sustainability refers to the current and future financial soundness of the schemes. That is, the pension system should be structured so that the financial situation does not require unexpected contribution hikes, unannounced future benefit cuts, or major and unforeseen transfers from the general fiscal budget. Finally, the system is supposed to withstand major shocks and to remain viable under unforeseen circumstances, i.e. it must be robust.

With this combination of various pillars, the World Bank follows *explicitly* the diversification idea from finance. The multi-pillar approach can be viewed as a portfolio-like combination of pension systems to address and manage the risks of aging. This view of pension mechanism as risk management devices implies that their design must be based on an assessment of their capacity to manage the relevant risks on an individual and a collective level. Each pillar is characterized by consumption-allocating elements that can either be viewed

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<sup>12</sup>See ISSA [2003*a,b*, 2004*a,b*] for a detailed description of social security systems in the world. Kinsella and Phillips [2005] gives a detailed breakdown of the challenges of aging in pensions, health care, disability and well-being. Given its importance the social security issue is in the focus of most publications on aging, like Chand and Jaeger [1996], Lee and Skinner [1999], Mackenzie et al. [2001], Holzmann and Stiglitz [2001], European Commission [2001], Kinsella and Velkoff [2001], Jackson [2002], Dunaway and N'Diaye [2004], or Holzmann [2004].



as assets or as liabilities and affect individuals and society – like those of Fiscal Land – in this matter. The advantage of combining them is that the varying characteristics allow to achieve the desired individual and societal benefits, while minimizing the relevant risks. In other words, each individual pillar on its own has its drawbacks and problems.<sup>13</sup>

While the World Bank's pillars may refer to *five* different organizational structures for realizing pension systems institutionally, there are only *two* underlying principal methods of financing them: a *funded* pension systems resembles an investment fund in which the contributions allow to acquire assets used later to pay for the benefits. The described pay-as-you-go mechanisms, on the other hand, is an *unfunded* system, where no assets are set aside, but benefits are paid for by the pension sponsor as and when they are paid. Typically, PAYGO pension arrangements are financed directly from current working generation by wage-based contributions. While the problem with this method is evident given the expected rise in old-age dependency ratios, funded pension pillars face also the deteriorating consequences of global aging.

The so-called “asset market meltdown” as it was coined by Porterba [1998, 2001] is the most prominent hypothesis on demography's impact on asset returns. According to this hypothesis, the clustered retirement and following dis-saving of comparatively large baby-boomer cohorts may cause a stock market crash after this generation's synchronous saving behavior has driven up asset markets for 40 years. This argument extends the view of the much-publicized study of Mankiw and Weil [1989] on demography-driven housing demand. They argue that the age-specific demand will have negative implications for future house prices due to the aging of the population. Other alerters of the meltdown include Siegel [1998, “Sell? Sell to whom?”, p. 41] and Brooks [2000], who warns that historically high returns on the funded pension pillars might have been exceptions and will not be observed in the future. The significance of a possible meltdown for pension financing is highlighted by the OECD's [2004, p. 237] recent estimation that pension fund assets account for about 50% of member countries' market capitalization. For Porterba [1998], however, finding robust evidence in time series data for demography-driven changes in equilibrium returns on financial assets is difficult and he suggests caution in projecting large future changes in asset values. Yet, Lim and Weil [2003] show that in the presence of sufficiently large installation costs for physical capital, demographics do have the power to affect stock prices. Furthermore, hardly any study mentions or addresses the overall populations decline. However, the outlook to have fewer consumers in general is also unlikely to

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<sup>13</sup>See Holzmann and Hinz [2005, p. 61-63]. Holzmann [2000] provides an assessment of the historic correlation of the various pillars' returns. The prospects on reform of the U.S. Social Security System has revitalized the discussion: see Lindbeck and Persson [2003] Shiller [2003b], Nataraj and Shoven [2003] or Modigliani and Muralidhar [2004]. Note furthermore that occupational pensions do not represent a pillar per se, but constitute merely a convenient implementation form for the mandatory saving accounts in the second pillar.

have a positive meanings for corporate earnings and asset prices.<sup>14</sup>

To sum up, both the funded as well as the unfunded financing method for pension systems seem to be profoundly affected by the demographic change: the former due to possible negative effects on financial returns and the latter by worsening old-age dependency ratios commanding ever higher contributions from wages. Consequently, the World Bank is right to promote a multi-pillar approach for pensions. But the diversification strategy can only work if the uncertainties in the pension financing methods are not perfectly correlated. Hence, the exact role of this diversification must be assessed in more detail if Pensionomics wants to proceed towards an optimized pension portfolio.

### 1.3 Objective and Synopsis

This work focuses on the portfolio perspective of the two financing mechanisms in the multi-pillar pension system introduced above. Given the fact that all pillars are finally financed either by funded savings or by a pay-as-you-go mechanism, the question arises how much each should contribute – facing the risks and uncertainties just described.

#### *Portfolio Perspective*

With the big challenges population aging poses on global societies, the aim is to develop a reference point for the combination of financing methods in old-age provisions. While this has some connection to health and long-term care, the predominant focus is on the pension subject. Given the World Bank's three roles for pension systems, the scope here is clearly limited to the consumption smoothing function. While redistribution interventions aiming at preventing poverty in old age are clearly justified from ethic grounds, they are difficult to theoretically integrate into an economic efficiency perspective. So is the insurance-like social safety net character of pension systems. The recent extension to five pillars, where redistribution is tax-financed, justifies this simplification: the politically desired level of redistribution is better achieved by a separate, tax-based program than in combination with the general unfunded pension system. Neither will the family, as the most important and fascinating organizational unit in societies and the World Bank's fifth pillar, play a prominent role. All this is not intended to trivialize the generational fairness discussions, but to confine the analysis to purely economic grounds

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<sup>14</sup>Other contributions also assessing the impact of cohort sizes on asset markets are Bakshi and Chen [1994], Schieber and Shoven [1994], Yoo [1997], Bergantino [1998], Geanakoplos et al. [2002], or Davis and Li [2003]. Comments on Porterba's [2001] landmark article include Abel [2001] emphasizing the role of bequests and Campbell [2001] pointing out the rather constant aggregate saving rate. According to Porterba [2004] the current empirical findings are limited but suggest a modest impact of demography on asset values and returns.

with the traditional pillars of physical capital and human labor. Therefore, the portfolio perspective taken here is clearly not the exhaustive answer on the design of the multi-pillar pension problem, but only a subordinated and limited view providing a theoretic reference point. However, there are no restrictions concerning the goals which the World Bank set for pension schemes: life-time adequacy, affordability, sustainability and robustness are clear prerequisites for a genuine answer to the pension problem.

In this sense, this work focuses on the principle of *efficiency* in the management of risks. As the optimization of expected returns in relation to the associated risks through diversification of the elements is the key idea in any portfolio formation, so it is here for the design of the overall system: How and why shall funded and unfunded pension arrangements be combined in order to deliver retirement income more effectively and efficiently?

### *Overview*

The answer to this question is neither a trivial nor a short one. It will be argued that the unfunded pay-as-you-go mechanism supplements funded pension provisions by allowing to virtually trade human capital. This insight is gained on basis of individual portfolio formation; yet, it also determines the role of each financing method in the multi-pillar approach. This portfolio understanding of the pension problem is built in three parts visualized in Fig. 1.1.

Part I comprises this Chap. 1's introduction to the phenomenon of global aging as motivation to analyze the pension problem as well as a survey of economic and financial theories related to it in Chapter 2. This establishes the theoretical requirements for the portfolio perspective and serves as methodological foundation for the analytical framework. This model is developed in Part II: Chapter 3 develops a general equilibrium model with overlapping generations that allows to address a hypothetical pension portfolio consisting of physical and human capital securities. This serves as first-best benchmark model for the replication following in Chap. 4. In this second-best approach, human capital is no longer marketable but a pay-as-you-go pension system and a consumption tax allow to achieve the same allocations as in the benchmark. Based on this indirect portfolio model, Part III derives implications for the pension problem. Chapter 5 analyzes the replication framework with respect to the requirements and to its theoretical consistency. Important implications on the potentials of risk diversification and on the design of PAYGO schemes are derived. Chapter 6 concludes with a summary on these insights and an outlook on further research.

**PART I: THE PROBLEM**

<ul style="list-style-type: none"> <li>• Aging as global phenomenon</li> <li>• Pension problem arising</li> </ul>	<ul style="list-style-type: none"> <li>• Requirements for approach</li> <li>• Economic and financial theory</li> </ul>
<p><b>Chap. 1</b> Global Aging and Pensionomics</p>	<p><b>Chap. 2</b> Methodical Foundation</p>

**PART II: THE MODEL**

<ul style="list-style-type: none"> <li>• Hypothetical portfolio construction</li> <li>• First-best benchmark model</li> </ul>	<ul style="list-style-type: none"> <li>• Pay-as-you-go pension scheme</li> <li>• Second-best replication</li> </ul>
<p><b>Chap. 3</b> Tradable Human Capital</p>	<p><b>Chap. 4</b> Replication with PAYGO</p>

**PART II: THE IMPLICATIONS**

<ul style="list-style-type: none"> <li>• Consistency and risk diversification</li> <li>• Design of PAYGO schemes</li> </ul>	<ul style="list-style-type: none"> <li>• Insights on Pensionomics</li> <li>• Outlook and further research</li> </ul>
<p><b>Chap. 5</b> Discussion and Assessment</p>	<p><b>Chap. 6</b> Summary and Conclusion</p>

**Fig. 1.2.** General overview

*Remarks:* This thesis consists of three parts: The first one nests the pension problem into the context of global aging. Part two develops a second-best framework showing that a PAYGO system allows to replicate tradable human capital. The last part analyzes this model and derives conclusions for the pension problem.

## Methodical Foundation

*In fact, virtually nothing in the daily news will change how we live and what we do more than the global population shift now under way.*

*Kotlikoff and Burns [2004]: "The Coming Generational Storm", p. 35*

With the understanding on the profoundness of the upcoming demographic change this chapter sets the requirements for the answer to the pension problem: without contradicting macroeconomic feedback mechanisms, the approach must simultaneously consider the funded and unfunded financing method in a financial risk-return perspective. To achieve this, Pensionomics will combine and extend prominent theoretical concepts from finance and economics. This review links these contribution to the pension issue and evaluates their limitations.

### 2.1 Outline and Requirements

Motivated by the deep impact of global aging, one must also build an understanding of the need for an extended economic model to address the portfolio perspective on pensions. This chapter realizes this in three major steps. Firstly, based on the World Bank's intention to establish the multi-pillar approach as an effective and efficient way to deliver retirement income, the remainder of this section will develop three dimensions that interpret the bank's goals of adequacy, affordability, sustainability and robustness in an integrated manner. Secondly, Sect. 2.2 reviews major contributions of finance and economics with regard to these dimensions. As this step into Pensionomics builds on the neoclassical paradigm, the established findings on the portfolio approach, asset pricing, q-measure theory, economic growth and public finance form the theoretical foundation. The section also illustrates the linkages between the different theoretical areas. Though their rather separate development allowed for a certain division of labor between researchers, they have all some connection to the pension problem, but cannot cope with it completely. Based on these major building blocks, Chaps. 3 and 4 will therefore develop a distinctive replication framework for addressing the portfolio perspective on the pension problem. Because this follows a rather non-standard strategy,

Sect. 2.3 serves, finally, as a survey on the proposed replication approach and relates it to the specified dimensions.

### *Motivation of Requirements*

Even though the pension issue seems to be a predominantly financial topic, it cannot be comprehensively solved within the financial perspective only. Since demography affects all economic markets, Pensionomics must not fall short of accurately addressing these changes and their consequences for retirement income. Principally, any analysis must thus include not only the market for capital assets but also for human labor and consumption goods as well as those for foreign exchange and the domestic currency. Two simplifying restrictions are made in this regard: this approach will limit itself to the analysis of a closed economy and thus abstract from international aspects in any of these markets and ignore the foreign exchange market. This is a clear simplification and is only tentatively justified by the fact that aging is a global phenomenon. Furthermore, there will also be no role for monetary aspects. In other words, the framework will be in real terms without a money market. The justification for this simplification is the very long-term focus of the analysis, as the demographic change realizes itself only gradually.<sup>1</sup>

Consistency in the remaining markets is a prerequisite for the approach. Economic growth theory, analyzing the effect of changes in a macroeconomic production factor like the population, is the natural link for them. Figure 2.1 illustrates the line of reasoning for the impact of demographic change.

On the one hand, population aging due to declining birth rates and higher life expectancy leads to decreasing cohort sizes. On the other hand, a different demographic composition of the total population implies a different aggregate savings behavior. Along these lines, demographic change affects human labor as well as physical capital. Both serve as input factors for the macroeconomic production of output, so that the goods market is affected, too. Based on the neoclassical marginal productivity theory, the distribution of income to labor and physical capital is thus also influenced by the altering demography. While physical capital's income reflects directly the uncertain return of funded pension savings, income from human labor is crucially determining the risk and return characteristics of the unfunded PAYGO system. The portfolio of both

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<sup>1</sup>There is still surprisingly little research in the monetary field; see e.g. Auerbach and Herrmann [2002], Fitoussi [2003] or Davis [2004]. The international perspective is dominated by estimations of demography-driven capital flows like Börsch-Supan et al. [2002], Börsch-Supan et al. [2003], Brooks [2003], Domeij and Floden [2003], Feroli [2003], Börsch-Supan et al. [2005], or Domeij and Floden [2005]. Still, exchange rate effects are hardly assessed. Migration – as the labor market consequence of openness – is discussed, for instance, in Winkelmann and Zimmermann [1992], Alvarado and Creedy [1998], United Nations [2000] or Börsch-Supan [2003]. As indicated in Chap. 1, immigration turns out to be an unlikely cushion for older countries, as it requires substantially large magnitudes to offset the birth-decline; for *global* aging it can definitely not help.

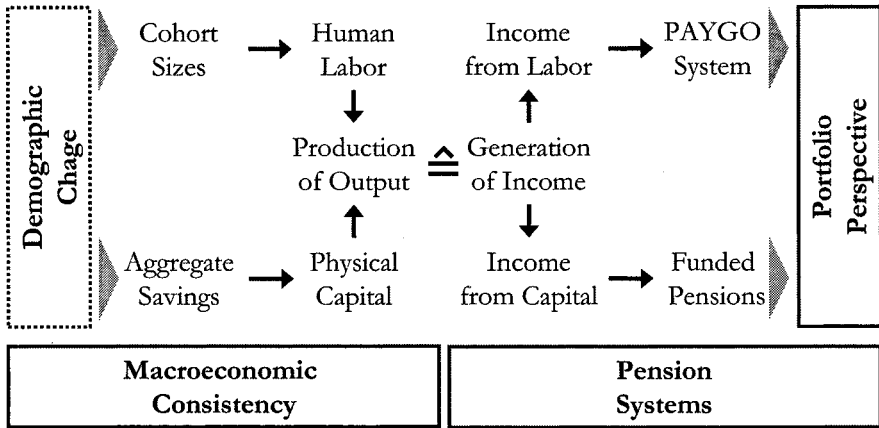


Fig. 2.1. Required dimensions

*Remarks:* A neoclassical intuition on the economy's interrelations implies that a genuine answer to the pension problem must meet three dimensions: (1) address funded and unfunded pension systems, (2) in a portfolio perspective under the condition of (3) macroeconomic consistency.

financing mechanisms reflects thus not only the demography-driven change in the capital market but also the aging's impact on the labor and the output market.

### *Required Dimensions*

Based on this intuition, requirements in three dimensions can be established, which the investigation of the portfolio problem must satisfy. These dimensions are clearly related to the World Bank's goals of life-time adequacy, affordability, sustainability and robustness for the multi-pillar approach.

Firstly, the investigation must acknowledge that there are two basic forms of pension financing: the pay-as-you-go mechanism and funded savings. As mentioned earlier, this analysis will neither focus on the redistributive role nor on the institutional implementation. Therefore, the funded and the unfunded pension mechanisms constitute this analysis's understanding of *pensions systems* – even though the World Bank states five pillars.<sup>2</sup> As indicated in Fig. 2.1, the pay-as-you-go system is typically associated with the labor input factor and its income, whereas funded savings relate to investments and hence to the stock of physical capital. Since it will be required that the two

<sup>2</sup>It is therefore justified to equate the PAYGO pension system with public or unfunded pensions and the funded component with private savings. However, the replication framework in Chaps. 3 and 4 will suspend this distinction to some degree for methodological purposes.

systems must operate within their factor's financing capacity and allow individuals' participation in both, the World Bank's goal of individually and socially affordable systems is attained.

Secondly, the investigation must be consistent in a macroeconomic sense. The usual partial portfolio analysis in finance is based on the assumptions of marginality, i.e. the individual behavior has no impact on the aggregate development. The pension issue, however, requires to examine the economic activity of entire cohorts, whose aggregate behavior is not marginal but will have important consequences for the economic development and thus for the functioning of both pension systems. Therefore, *macroeconomic consistency* is mandatory: the implications of the analysis must still hold when all individual agents act as the portfolio view implies. In this sense, any solution must be subject to the condition of sustainable policies in the pay-as-you-go system and any other public intervention, above all concerning the expected population decline.

And thirdly, the investigation must – of course – take the *portfolio perspective*. As all pension systems are exposed to multiple risks in form of economic, demographic, and political uncertainty the World Bank's multi-pillar approach encourages diversification across different systems. This requires a finance-driven portfolio model to simultaneously address the risk-return characteristics of the funded and unfunded pension systems. This achieves robustness with respect to shocks from the mentioned uncertainty factors. Furthermore, a portfolio approach extended by the intertemporal consumption-savings decision – as usual in finance – addresses the adequacy of retirement income in terms of consumption smoothing over the individual lifetime.

These three dimensions are clear prerequisites for a genuine answer to the pension problem. Disregard of one will substantially alter the result, because funded and unfunded pension provisions co-exist, are characterized by specific risks and have feedback mechanism in an aggregate perspective.

### *Existing Research*

Existing research neglects at least one of the dimensions – or does not explicitly address all of them. Though simulation studies like Brooks [2002] or Börsch-Supan et al. [2003] address the PAYGO system and macroeconomic aspect at detailed levels concerning the demographic composition and the public pension system, they ignore the portfolio dimension in combining the pensions mechanisms. Contributions from financial economics like Merton [1969b], Samuelson [1969] or Campbell and Viceira [2001a] focus thoroughly on the uncertainty aspect concerning allocations of savings or address uncertainty in the macroeconomic production relations – like Brock and Mirman [1972], Merton [1975] and Cox, Ingersoll and Ross [1985a,b]. Yet, they all ignore human labor as an input factor to production and hence the unfunded pension system as an alternative. Pure portfolio considerations of both systems like Dutta et al. [2000], Baxter and King [2001], Schacht [2001], Matsen and Thøgersen [2004] or Borgmann [2005, Chap. 7] lack macroeconomic consistency. Given the remarkable future growth in the old-age dependency ratio