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Chapter 2:

A Way to Formalization

Investing in emerging markets is no panacea for OECD population aging: results from an exploratory simulation with a neoclassical model

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1. Introduction

The problem of coping with an aging population is typically framed as a problem of national policy making. In a tightly integrated global economy, this is a great mistake. Yet, simplistic global views can be almost as bad as no global view at all. One such view is that OECD investments in non-OECD emerging markets can "solve" the aging problem, or at least solve its retirement saving / pension component. In this note, results from an exploratory simulation of the impacts of projected changes in global population age structures on the world economy under baseline and alternative assumptions regarding international capital mobility are summarized. The conclusion is that, if investment in emerging markets is to make a significant contribution to reducing the economic costs of aging in the OECD, the mechanisms must be found outside the elementary neoclassical economic theory. Globalization of investment enhances global efficiency and equity, but it is no panacea for OECD population aging.

2. Key questions

One influential view is that investing OECD pension resources in more dynamic emerging markets could reduce baby boomers' cost of accumulating retirement assets while relieving pressure on pay-as-you-go (PAYG) corporate and public pension systems. At the same time, increased capital in the LDCs and transition economies would stimulate growth, reduce inequities, strengthen the world economy, and lay the basis for robust international trade.

This scenario, while plausible, requires much deeper analysis within the broad framework of global (not just OECD) population aging, capital market integration, and likely changes in pension, retirement, and health care policies. The following are among the key questions which must be addressed:

Saving rates How will expected changes in population age distributions affect the household saving rate? How can changing social security arrangements affect the level of national saving (both public and private)?

Fiscal accumulation How will population aging affect the tax base and government expenditures, given assumptions about the nature of pension, retirement, and health care policies?

Labor markets Will elderly labor force participation rates remain low in the OECD? Will LDCs replicate the historical experience of the OECD countries as they develop? How can changing social security arrangements affect the level of labor force participation of the elderly? How do non-wage labor costs affect the level of unemployment?

Productivity How do aging and the nature of the social security system affect human capital formation and the rate of technical change? What is the impact of the social security tax wedge on the allocation of productive resources?

Asset markets How will changing supply-demand conditions in asset markets related to changes in population age structure affect equity and real estate prices and bond yields? Will there be "asset meltdown" as baby boomers retire and begin to sell off accumulated assets to a much smaller cohort of retirement savers?

Trade and exchange rates Will, as appears likely *a priori*, population aging tend to reduce saving more than it will reduce investment, thus leading to weakening of trade balance and depreciation of real exchange rates in the most rapidly aging economies? How large must swings in real exchange rates be to force real resource transfers corresponding to anticipated capital flows? How will aging affect the prices of tradeable and non-tradeable goods? Do non-wage labor costs arising

from the public pension and health care system have an appreciable impact on export prices, and thus the trade balance?

International capital flows What impact will international capital flows have on financial rates of return in sending and receiving regions? How important will the resulting offsets be, for example, when capital inflows reduce the rate of return to capital and thus potentially discourage domestic saving? How important is foreign investment in improving the efficiency of the financial systems and promoting better corporate governance?

Fairness, equity, and political economy How are younger workers, older workers, and pensioners affected under different policy scenarios? Are there substantial differences between impacts on men and impacts on women? What do political scientists' models reveal about the nature of social security reform and the likelihood of major institutional changes?

3. An exploratory model simulation

One approach to take when entering a rich and complex research area is to elaborate a simple neoclassical model whose predictions can serve as a baseline for judging richer, more realistic, and less mathematically formal models. A joint research paper of International Institute for Applied Systems Analysis (IIASA) and Organisation for Economic Co-Operation and Development (OECD) Development Centre (Landis MacKellar and Helmut Reisen, "A Simulation Model of Global Pension Fund Investment," IIASA *Interim Report* 1997-75) employs a very simple two-region (OECD / non-OECD) economic-demographic growth model to quantify the outlook for economic growth, international capital flows, rates of return to capital, and consumption levels of workers and pensioners in the light of global demographic divergence. The demographic outlook plays a central role, as population aging shifts both the balance of contributors to and beneficiaries from the public and corporate defined-benefit pension systems (assumed to be financed on a PAYG basis) and the balance of net savers and dissavers in the private defined-contribution pension system (assumed to be fully funded). The model is entirely neoclassical: there are only two assets, domestic physical capital and foreign physical capital, the rates of return to which reflect the marginal productivity of capital and nothing else.

Three scenarios were examined for the period 1995-2050. Scenario 1, corresponding to conditions of no further integration of capital markets, assumes that the share of annual OECD savings invested in the non-OECD remains constant at 2% over the next 50 years. Scenario 2, corresponding to steady further integration,

assumes that this share rises to 5% in 2020 and 10% in 2050. Scenario 3, which is admittedly unlikely, assumes that rapid financial globalization causes the share to rise to 15% in 2020 and to stay at this level throughout the simulation period.

Summary results from this exploratory simulation are given in Table 1, and a description of the simulation model is attached as an Annex. The model, and simulation results, are available from the author in the form of an EXCEL spreadsheet.

The core result of the simulation is that, while increased OECD investment in the non-OECD reduces OECD gross *domestic* product, it increases OECD gross *national* product (and *vice versa* for the non-OECD). For a range of reasonable assumptions on the proportion of foreign earnings repatriated, this result is in line with theory, and indeed could be predicted without the model. Since investment has been re-allocated from the low marginal product of capital region to the high marginal product of capital region, world GDP is higher; at the end of the simulation period by 0.3% in Scenario 2 and 0.6% in Scenario 3. Also straightforward is the impact of greater capital mobility on workers in the two regions: non-OECD workers unambiguously gain, as they have more capital to work with, while OECD workers unambiguously lose, as they have less capital to work with. The impact of capital mobility on pensioners, by contrast, is theoretically indeterminant. In the OECD, pensioners lose because, as workers, they had lower levels of wages out of which to save; on the other hand, those savings earned a higher rate of return because re-allocation of investment to the non-OECD made capital more scarce in the sending region. Pensioners' receipts from OECD PAYG pension schemes, including public pension systems, would be lowered by the negative impact of capital mobility on OECD wages. The same story can be told in reverse for the non-OECD, leading to the conclusion that it is impossible to predict *a priori* the impact of increased foreign investment on the welfare of non-OECD pensioners.

In the event, the model predicts reductions in the consumption of pensioners in both regions as a result of capital mobility. The reduction in the non-OECD is a bit misleading, since it would be easy to divert gains from workers to retirees through higher payroll taxes or intrafamily transfers. This would not be possible in the OECD. More aggressive consumption of factor payments from abroad could presumably nudge OECD pensioners' consumption back towards its baseline level, but the lower the reinvestment of earnings on foreign direct investment, the lower the overall GNP gain. All things considered, the simulation suggests that, if increased OECD investment in the non-OECD is to reduce significantly the costs of aging in the OECD, it will have to do so following a logic richer than that of elementary neoclassical theory. Capital market imperfections, not reflected in our model,

might allow OECD investors in the non-OECD to reap a risk premium over and above the rate of return to physical capital. Under such a scenario, while increased capital mobility would reduce the "spread" between rates of return to physical capital (as in our scenario), the increased net foreign liabilities of non-OECD countries would increase the risk premium and thus widen the "spread." It is, for example, easy to show that all parties with the exception of OECD workers gain from increased capital mobility if rates of return to capital are frozen at their baseline levels. On the other hand, as current events in Asian financial markets remind us, risk premia exist for a reason. Neoclassical theory is hostile to the persistence of risk-adjusted rate-of-return differentials over the long time frame which is relevant for analyzing the impacts of population aging.

4. Conclusion

While more rational global allocation of investment is assuredly a good thing, our results suggest that it is by no means a panacea for the economic challenge of OECD population aging. These discouraging results could be mitigated, or even reversed, by inclusion of risk premia, by changing assumptions on reinvestment of earnings on direct foreign investment, or by incorporating a range of effects described above under "Key Questions." The world is assuredly not so neoclassical as our model assumes. Experience has been unkind, however, to predictions and policies which fly in the face of elementary neoclassical logic. The bottom line of our simulation is that world GDP *per capita* is increased by a fraction of a percentage point over half a century. That is not a great deal, so the burden of proof in this case is on enthusiasts of aggressive international investment strategies, not on the skeptics.

Table 1: Summary simulation results

	1995	2020	2050
Per capita GDP (1995 US $)		*OECD*	
Scenario 1	24634	32883	40620
Scenario 2	24634	32758	40131
Diff. (%)*	0.0	-0.4	-1.2
Scenario 3	24634	32308	39179
Diff. (%)	0.0	-1.7	-3.5
Per capita GDP (1995 US $)		*non-OECD*	
Scenario 1	1538	2856	5186
Scenario 2	1538	2889	5291
Diff. (%)	0.0	1.2	2.0
Scenario 3	1538	2998	5474
Diff. (%)	0.0	5.0	5.6
Per capita GDP (1995 US $)		*World*	
Scenario 1	6605	7959	9917
Scenario 2	6605	7965	9943
Diff. (%)	0.0	0.1	0.3
Scenario 3	6605	7979	9974
Diff. (%)	0.0	0.3	0.6
Per capita GNP (1995 US $)		*OECD*	
Scenario 1	24709	33401	42241
Scenario 2	24709	33529	43197
Diff. (%)	0.0	0.4	2.3
Scenario 3	24709	33712	44051
Diff. (%)	0.0	0.9	4.3
Per capita GNP (1995 US $)		*non-OECD*	
Scenario 1	1517	2750	4936
Scenario 2	1517	2731	4818
Diff. (%)	0.0	-0.7	-2.4
Scenario 3	1517	2710	4723
Diff. (%)	0.0	-1.4	-4.3
Rate of return to capital (incl. depreciation)		*OECD*	
Scenario 1	0.104	0.086	0.079
Scenario 2	0.104	0.086	0.081
Diff. (%)	0.000	0.001	0.002

Summary Results, continued

	1995	2020	2050
Rate of return to capital (incl. depreciation)		*OECD, ctd*	
Scenario 3	0.104	0.089	0.085
Diff. (%)	0.000	0.003	0.006
Rate of return to capital (incl. depreciation)		*non-OECD*	
Scenario 1	0.131	0.108	0.105
Scenario 2	0.131	0.105	0.100
Diff. (%)	0.000	-0.003	-0.005
Scenario 3	0.131	0.098	0.094
Diff. (%)	0.000	-0.010	-.011
Workers' consumption (1995 US $)		*OECD*	
Scenario 1	23653	33321	46910
Scenario 2	23653	33194	46345
Diff. (%)	0.0	-0.4	-1.2
Scenario 3	23653	32739	45246
Diff. (%)	0.0	-1.7	-3.5
Workers' consumption (1995 US $)		*non-OECD*	
Scenario 1	1790	3226	5937
Scenario 2	1790	3263	6058
Diff. (%)	0.0	1.2	2.0
Scenario 3	1790	3386	6267
Diff. (%)	0.0	5.0	5.6
Pensioners' consumption (1995 US $)		*OECD*	
Scenario 1	15294	16205	16521
Scenario 2	15294	16179	16483
Diff. (%)	0.0	-0.2	-0.2
Scenario 3	15294	16069	16382
Diff. (%)	0.0	-0.8	-0.8
Pensioners' consumption (1995 US $)		*non-OECD*	
Scenario 1	745	1343	2007
Scenario 2	745	1340	1970
Diff. (%)	0.0	-0.3	-1.8
Scenario 3	745	1334	1912
Diff. (%)	0.0	-0.7	-4.7

* differences with respect to Scenario 1.

Annex: The simulation model

Population and labor force

Population and age-specific labor force participation rates are exogenous variables. The population consists of 0-14 year-olds, who neither work nor save; 15-59 year olds, most of whom work and save for retirement; and 60+ year olds, who neither work nor save.

$$L_i(t) = Pop15\text{-}59_i(t)\ LFPR15\text{-}59_i(t)$$

$$Ret_i(t) = Pop60+_i(t)$$

All labor is assumed to be employed.

Output and rates of return to factors

GDP is given by Cobb-Douglas production functions and rates of return to factors are neoclassical:

$$Y_i(t) = \alpha\ K_i(t)^{\beta_i}\ [L_i(t)^{g_i}]^{1-\beta_i}$$

$$r_i(t) = \beta_i\ [Y_i(t) / K_i(t)]$$

$$w_i(t) = (1-\beta_i)\ [Y_i(t) / L_i(t)]$$

where g_i is the rate of labor productivity growth.

Saving and capital formation

Leaving re-invested earnings aside for the moment, retirement savings $RetSav_i(t)$ are assumed to come entirely out of after-tax wage income:

$$RetSav_i(t) = RetSavRate_i(t)\ w_i(t)\ L_i(t)\ [1 - DirTaxRate_i(t) - SocSecTaxRate_i(t)]$$

Saving out of PAYG social security benefits is assumed to be zero. Retirement savings are shared out among the two regions by means of exogenous flow coefficients $ShPens_{ij}(t)$.

Earnings on the portion of pension capital owned by savers are re-invested where they are earned; if earned domestically, they are assumed to be free of tax, but if earned abroad, they are assumed to be subject to taxes. Earnings on that portion owned by pensioners are assumed to be consumed. Retirees sell off a portion of the pension capital stock which they own, and the existing stock of machines is depreciated.

This gives us the following accumulation function for pension capital:

$$\Delta\ KPens_{ij}(t) = RetSav_i(t)\ ShPens_{ij}(t) +$$
$$\sigma_i(t)\ r_j(t)\ KPens_{ij}(t)\ [1 - DUM_{ij}\ DirTaxRate_j(t)]$$
$$- [1 - \sigma_i(t)] \frac{1}{E60_i(t)}\ KPens_{ij}(t) - \delta\ KPens_{ij}(t)$$

where DUM_{ij} is equal to 1 if i and j are different regions and 0 if not. The first term in the equation is the flow of savings out of wages; the second is reinvested earnings. The third term of the equation, which captures retirees' decumulation, is explained as follows. At age 60, all persons are assumed to begin consuming their pension savings at a rate calculated to exhaust savings at the point of death. Because interest earnings on the remaining stock are assumed to be consumed in their entirety, we need not worry about accruing earnings on assets which are in the process of being drawn down. The annual decumulation rate is therefore simply the inverse of life expectancy at 60, $E60_i(t)$. Decumulation is assumed to be free of tax.[1]

Non-retirement related savings come entirely out of profits and the marginal propensity to save out of profits is assumed to be unity. As discussed above, earnings on domestic capital finance further investment both at home and abroad, whereas earnings on capital installed abroad finance only further investment abroad. Using notation similar to that already introduced for the case of pension capital,

$$\Delta\ KOth_{ij}(t) = r_i(t)\ KOth_{ii}(t)\ [1 - DirTaxRate_i(t)]\ ShOth_{ij}(t)$$
$$+ DUM_{ij}\ r_j(t)\ KOth_{ij}(t)\ [1 - DirTaxRate_j(t)] - \delta\ KOth_{ij}(t)$$

The first term of the equation is the sharing-out of domestic earnings between reinvestment at home and investment abroad; the second is the reinvestment of earnings on capital owned abroad (both after tax).

Total capital in each region is the sum over all types of capital installed (domestically-owned pension capital, domestically-owned non-pension capital, foreign-owned pension capital and foreign-owned non-pension capital):

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1 In a more recent version of the model, the annual decumulation is calculated as an actuarial annuity designed to exhaust total savings between ages 60 and 60+$E60_i(t)$. This has the effect of making the annuity a function of $r_i(t)$ and $r_j(t)$. The tax treatment of the retirement annuity is also being modeled. Neither of these clean-ups is likely to change substantially the results presented here.

$$K_i(t) = \sum_{j=1}^{2} [KPens_{ji}(t) + KOth_{ji}(t)]$$

Consumption

The annual consumption of the average worker is equal to the wage rate minus the retirement savings rate minus the direct tax rate minus the proportion of income transferred to the 60+ population through the PAYG social security system:

$$ConWrk_i(t) = w_i(t)\,[1 - RetSavRate_i(t) - DirTaxRate_i(t) - SocSecTaxRate_i(t)]$$

The annual consumption of the average pensioner consists of three streams: dissaving in the form of asset sales; the stream of interest on remaining pension assets, all of which is assumed to be consumed; and the transfer from the working population *via* the PAYG social security system:

$$ConRet_i(t) = \frac{1}{Ret_i(t)}$$

$$\left[\frac{[1-\sigma_i(t)] \sum_{j=1}^{2} KPens_{ij}(t)}{E60_i(t)} + [1 - \sigma_i(t)]\right.$$

$$\left.\sum_{j=1}^{2} [r_j(t)\ KPens_{ij}(t)\ DUM_{ij}\ DirTaxRate_j(t)] + SocSecBen_i(t)\right]$$

where social security benefits by definition equal social security contributions:

$$SocSecBen_i(t) = SocSecCon_i(t) = SocSecTaxRate_i(t)\ w_i(t)\ L_i(t)$$

Interest earnings on domestic pension savings are assumed to be free of income tax; earnings on foreign interest earnings are taxed.

Government consumption expenditure (implicitly including interest on debt) is taken as a fixed proportion of GDP; total government expenditure equals consumption plus social security benefits paid out. Government revenue is equal to the direct tax rate multiplied by wages plus profits plus social security contributions. Since social security benefits and contributions balance in this model by definition, government saving is equal to direct tax revenue minus government consumption. In summary,

$$GovCon_i(t) = \gamma_i(t)\ GDP_i(t)$$

$$GovExp_i(t) = GovCon_i(t) + SocSecBen_i(t)$$

$$GovRev_i(t) = DirTaxRate_i(t)\ w_i(t)\ L_i(t)$$

$$+ DirTaxRate_i(t)\ r_i(t) \sum_{j=1}^{2} KOth_{ji}(t)$$

$$+ DirTaxRate_i(t) \sum_{j=1}^{2} [1 - \sigma_j(t)]\ DUM_{ji}\ r_i\ KPens_{ji}(t)]$$

$$+ SocSecCon_i(t)$$

Gross and net factor payments from abroad are

$$FPA_{ij}(t) = \sum_{j=1}^{2} DUM_{ij}\ r_i(t)\,[KPens_{ji}(t) + KOth_{ji}(t)]\,[1 - DirTaxRate_i(t)]$$

$$NFPA_i(t) = \sum_{j=1}^{2} [FPA_{ji}(t) - FPA_{ij}(t)]$$

Net national saving is GDP plus net factor payments from abroad (*i.e.*, GNP) minus depreciation of capital owned both at home and abroad minus consumption:

$$NetNatSvng_{ij}(t) = GDP_i(t) + NFPA_i(t) - \delta[\sum_{j=1}^{2} KPens_{ij} + KOth_{ij}(t)]$$

$$- ConWrk_i(t)\ L_i(t) - ConRet_i(t)\ Ret_i(t)$$

Net national saving is also equal to savings from wage income plus savings from profits plus the government balance; the model is solved by iterating until net national savings from the two sides in both regions are equal.

Parameters and assumptions

The model was calibrated to reflect two regions, OECD and non-OECD,[2] and solved for 1995, 2020, and 2050. Demographic assumptions were taken from the most recent IIASA population projections. Using spreadsheet simulations with the rate of return equal to 10% per year, the proportion of OECD pension capital owned by persons over 60 was estimated to be 25%, 33%, and 50% for 1995, 2025, and 2050, respectively. Using an assumed rate of return of 15%, the proportion in non-OECD countries was estimated to be 15%, 20%, and 30%. While the estimation is quite crude, it appears from simulations that this important parameter is more sensitive to population age structure (and indeed tracks it rather closely) than to the assumed rate of return or saving rates. Life expectancy at 60 was assumed to be 25 years in the OECD and 15 years in the non-OECD.

Based on ILO estimates, labor force participation rates at age 15-59 (both sexes combined) in both OECD and non-OECD were assumed to be 0.75. Persons over 60 were assumed not to work: labor force participation rates at older ages are only about 5% in the OECD; while these rates are higher in the non-OECD, they are likely to decline rapidly with economic development. At least on a baseline-*versus*-alternative basis, simulation results are not very sensitive to the assumed labor force participation rates.

The β coefficient in the Cobb-Douglas production function was assumed to be 0.33 for both OECD and non-OECD. The rate of labor-augmenting technical progress was assumed to be 1% per year in the OECD and 2% per year in the non-OECD. Information from various sources on *per capita* GDP and capital-output ratios led us to initialize the model on *per capita* GDP levels of approximately $25,000 and $1,500 (1995 prices) in the OECD and non-OECD respectively, and capital-labor ratios of 3.18 and 2.52. Estimates of pension capital stocks allowed us to calculate other capital as a residual.

The household retirement saving rate was set at 5% in both regions for all time periods. This is not too far out of line with estimates for OECD countries; little information is available outside the OECD but, given the dearth of public pension

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2 There remain some apples-and-oranges consistency problems to iron out, but this should not change qualitative results. Specifically, the IIASA population data referred to as "OECD" in Table 1 exclude Mexico, Turkey and South Africa and include Eastern Europe plus European Former Soviet Union. The "non-OECD" aggregate is the rest of the world.

systems, it seems unlikely that the retirement saving rate would be lower than in the OECD. The rate of contribution to the public PAYG pension system, or alternatively, the rate of income transfer from wage earners to the inactive elderly, was set equal to 15% in the OECD and 5% in the non-OECD. All earnings to non-pension capital were assumed to be re-invested. The direct tax rate was assumed to be 15% in both regions and government consumption was assumed to be 20% of GDP. Combined with the shrinking tax base (a result of population aging), and keeping in mind that the PAYG social security system is in balance by definition this implied government budget deficits on the order of 5-6% of GDP over the entire simulation period.[3]

Further work

Work is currently underway on the following extensions and improvements of the two-region model, prior to expansion to cover more than two regions. In no particular order, such extensions and modifications include:

(i) Incorporation of a demographic projection module and re-specification of the model in single-year time steps.

(ii) Calculation of cohort-specific social security benefit rates as function of past labor force participation rates and wages.

(iii) Addition of human capital and endogenous productivity growth to the production function.

(iv) Improvement of the dissaving mechanism (calculate actuarial annuity; deal better with tax; allow for bequests).

(v) Better articulation of savings, replacement of extreme Kaldor assumption with more reasonable treatment of corporate savings, explicit treatment of employer-sponsored pension plans.

(vi) Incorporation of government debt, more attention to fiscal sustainability.

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3 A better articulation of saving; in particular, allowing for the possibility of consuming out of returns to non-pension capital (including imputed housing services) will reduce the private saving rate, thus making possible a baseline scenario which combines public fiscal sustainability with a reasonably moderate rate of net national saving. In scenario-building with the current exploratory model, it was necessary to extrapolate public sector budget deficits in order to ensure a reasonably restrained path for capital formation.

(vii) Incorporation of risk premium on non-OECD capital rising with net foreign liabilities.
(viii) Endogenization of age-specific saving rates.
(ix) Addition of international constrained optimisation routine to allocate global investment [just started]
(x) Incorporation of exchange rate and trade balance.
(xi) Addition of age-specific health spending.

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