LUH-Kolloquium „Versicherungs- und Finanzmathematik"
Insurance and Demography, Hannover 19.06.2014

Collective saving schemes and return smoothing mechanism

Oskar Goecke

Institut für Versicherungswesen

Forschungsstelle FaRis

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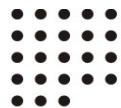
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Overview

- **Economic background/ interest rate environment/ risk premium**

- What does it mean „collective saving"?

- Results from theory

- Results from backtesting

- Concluding remarks

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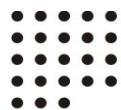
Interest rates (1972 – 2013)
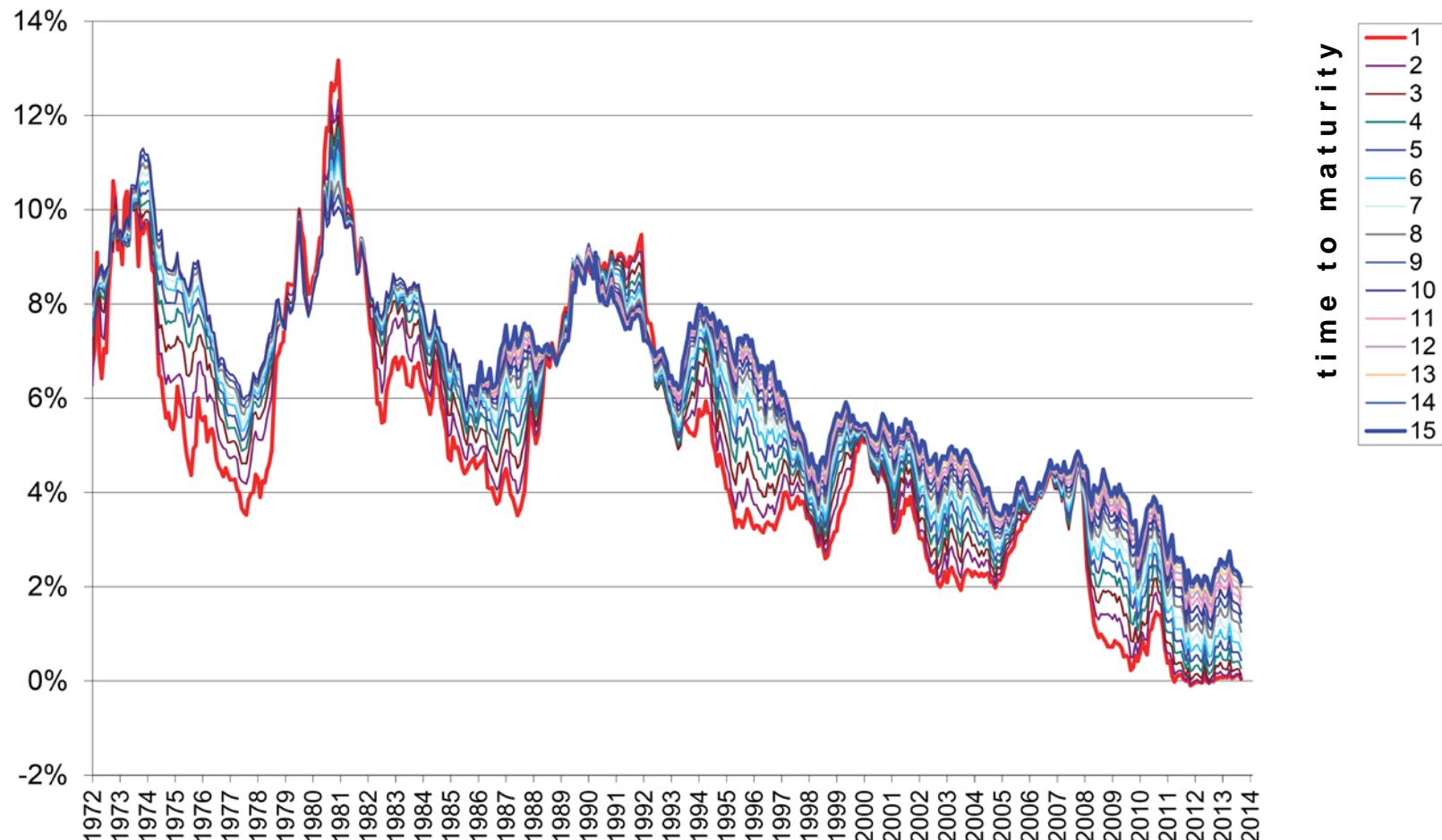
Source: Deutsche Bundesbank/ own calculations
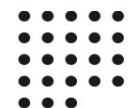
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Yield curve – secular trend
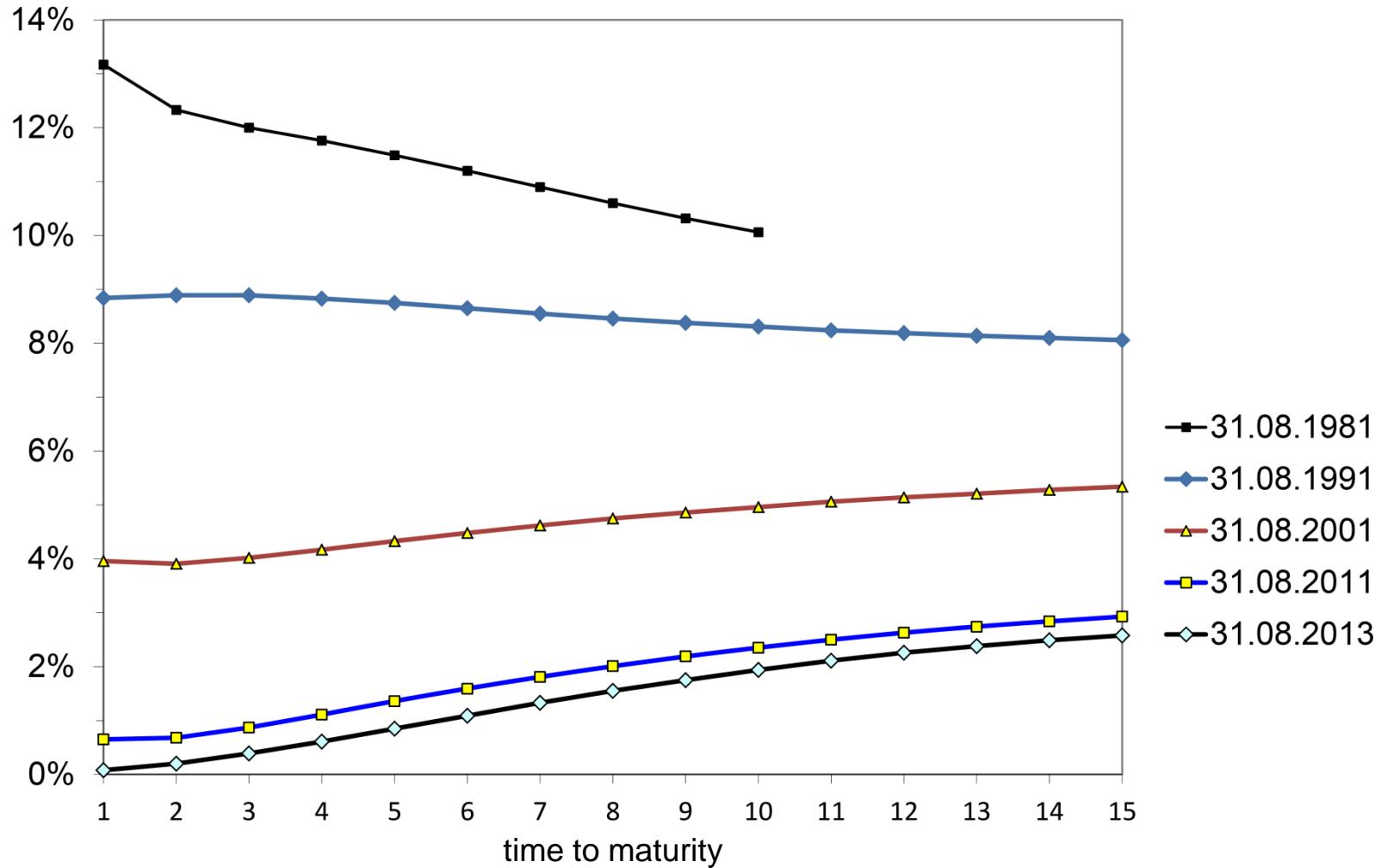
Source: Deutsche Bundesbank/ own calculations

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Yield 10-year Government bonds
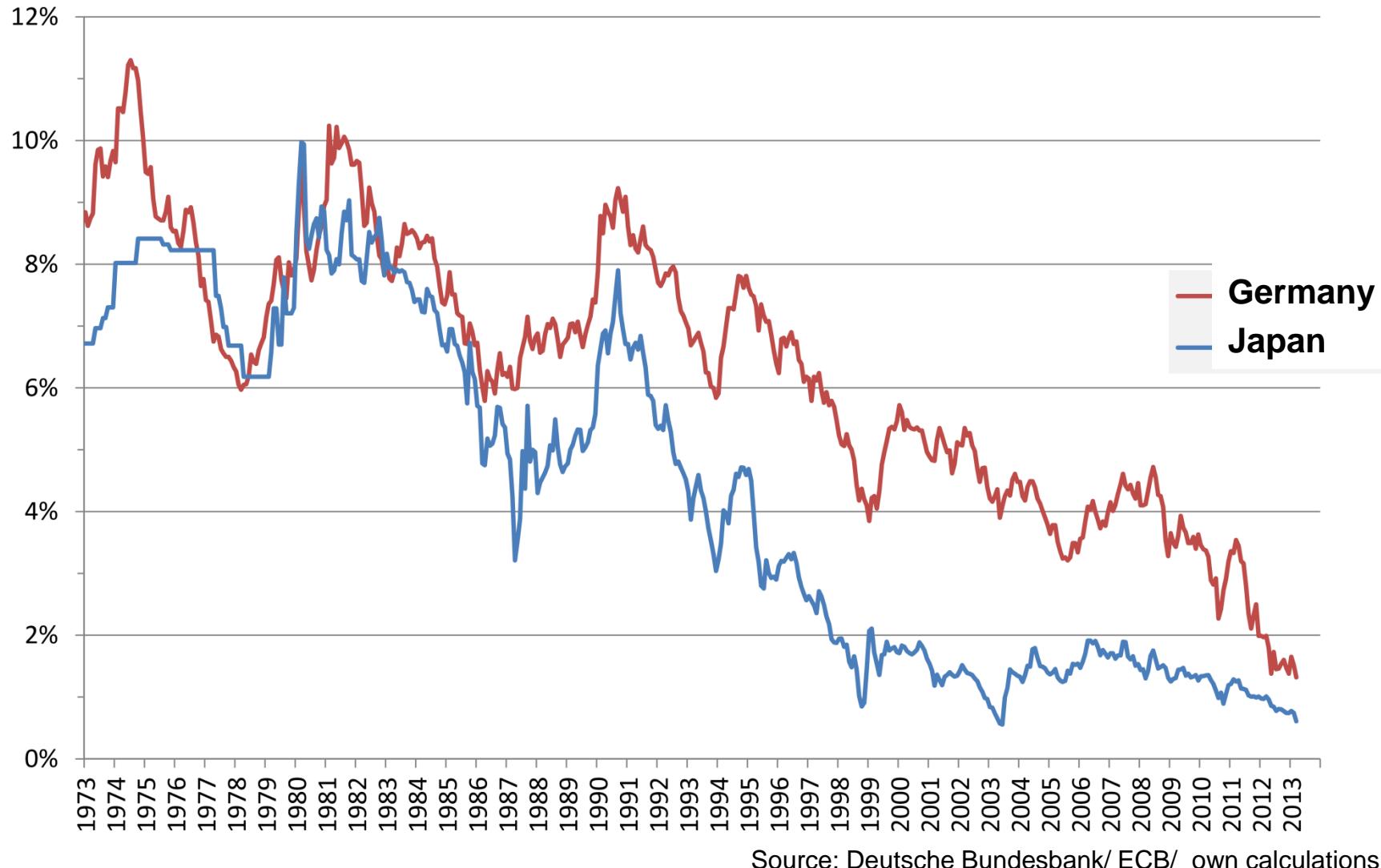
Source: Deutsche Bundesbank/ ECB/ own calculations
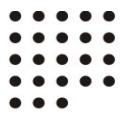
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There is no free lunch! Or: Risk pays off !
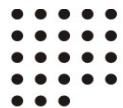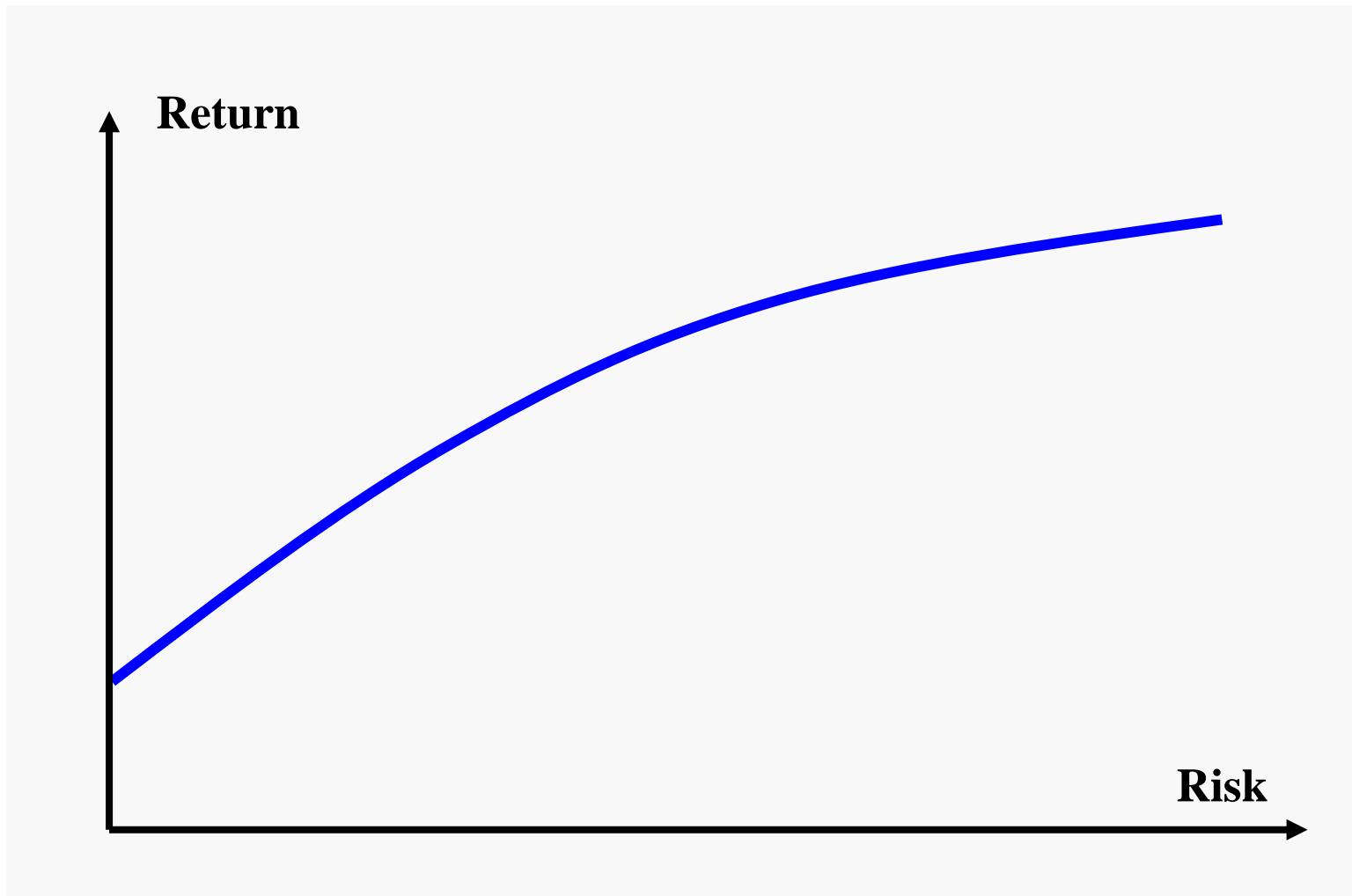
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# Risk Return-Transformation
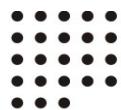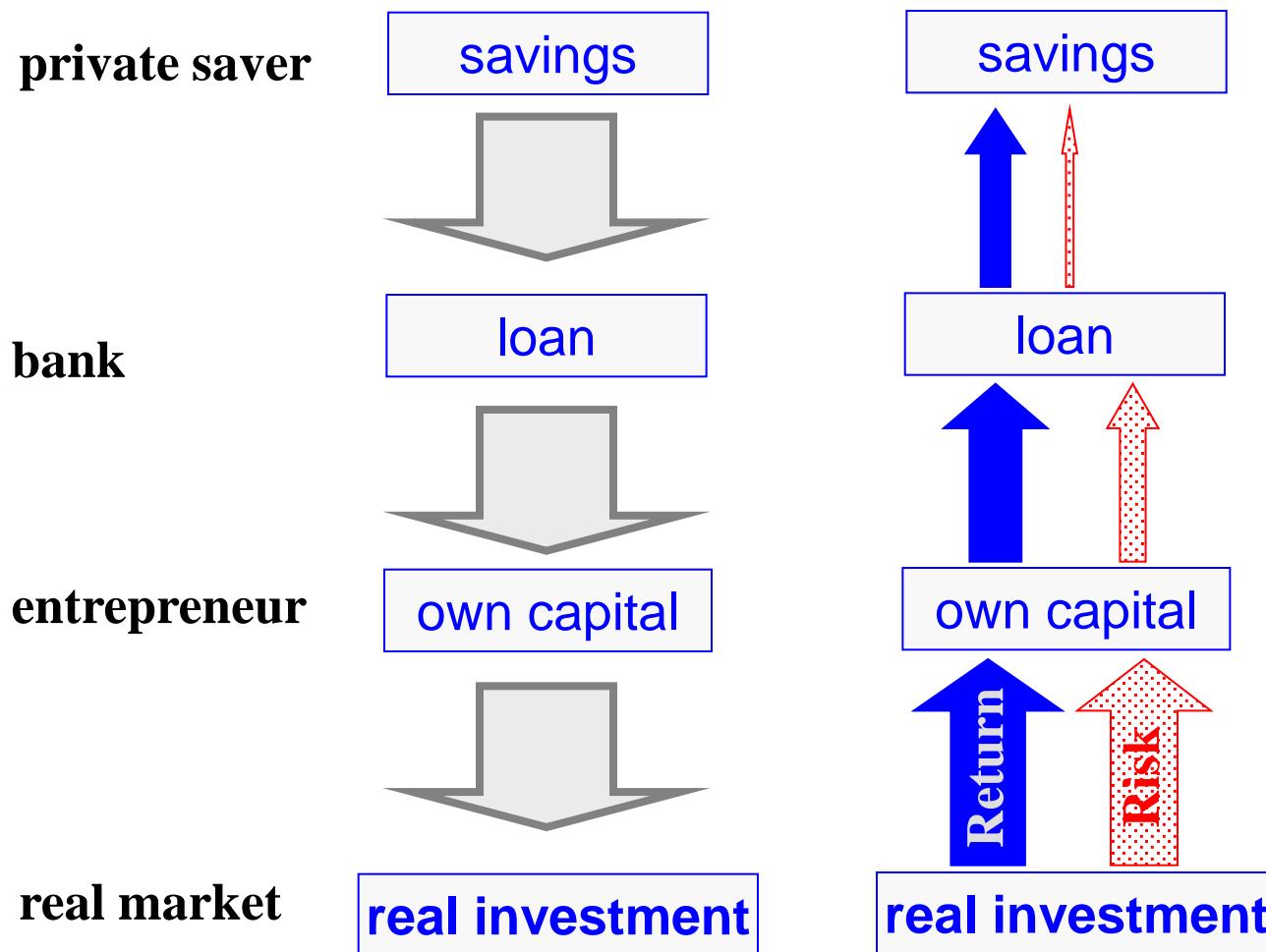
Risk pays off! – But how much?

Table 2. Market Risk Premium (MRP) used for 51 countries in 2013

MRP	Number of answers	average	Median	St. Dev.	max	min	Av-Median
USA	2394	5.7%	5.5%	1.6%	15.8%	2.5%	0.2%
Spain	804	6.0%	5.5%	1.7%	15.0%	3.0%	0.5%
Germany	343	5.5%	5.0%	1.7%	18.0%	1.6%	0.5%
United Kingdom	247	5.5%	5.0%	1.4%	11.0%	2.0%	0.5%
Italy	205	5.7%	5.5%	1.5%	12.0%	3.0%	0.2%
France	134	6.1%	6.0%	1.6%	12.0%	3.0%	0.1%
Switzerland	113	5.6%	5.5%	1.5%	12.0%	3.0%	0.1%
Brazil	112	6.5%	6.0%	2.1%	12.0%	1.6%	0.5%
Canada	110	5.4%	5.3%	1.3%	12.0%	3.0%	0.1%
China	95	7.7%	7.0%	2.3%	14.0%	3.0%	0.7%
Portugal	52	6.1%	5.9%	2.3%	12.0%	2.5%	0.2%
Norway	51	6.0%	6.0%	1.8%	12.0%	3.0%	0.0%
Greece	50	7.3%	6.0%	4.1%	20.8%	3.0%	1.3%
Sweden	50	6.0%	5.9%	1.7%	12.0%	3.0%	0.1%

Source: Fernandez/ Aguirreamalloa/ Linares (IESE Business School, June 2013), Internet survey bases on 6237 answers.
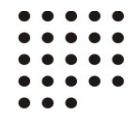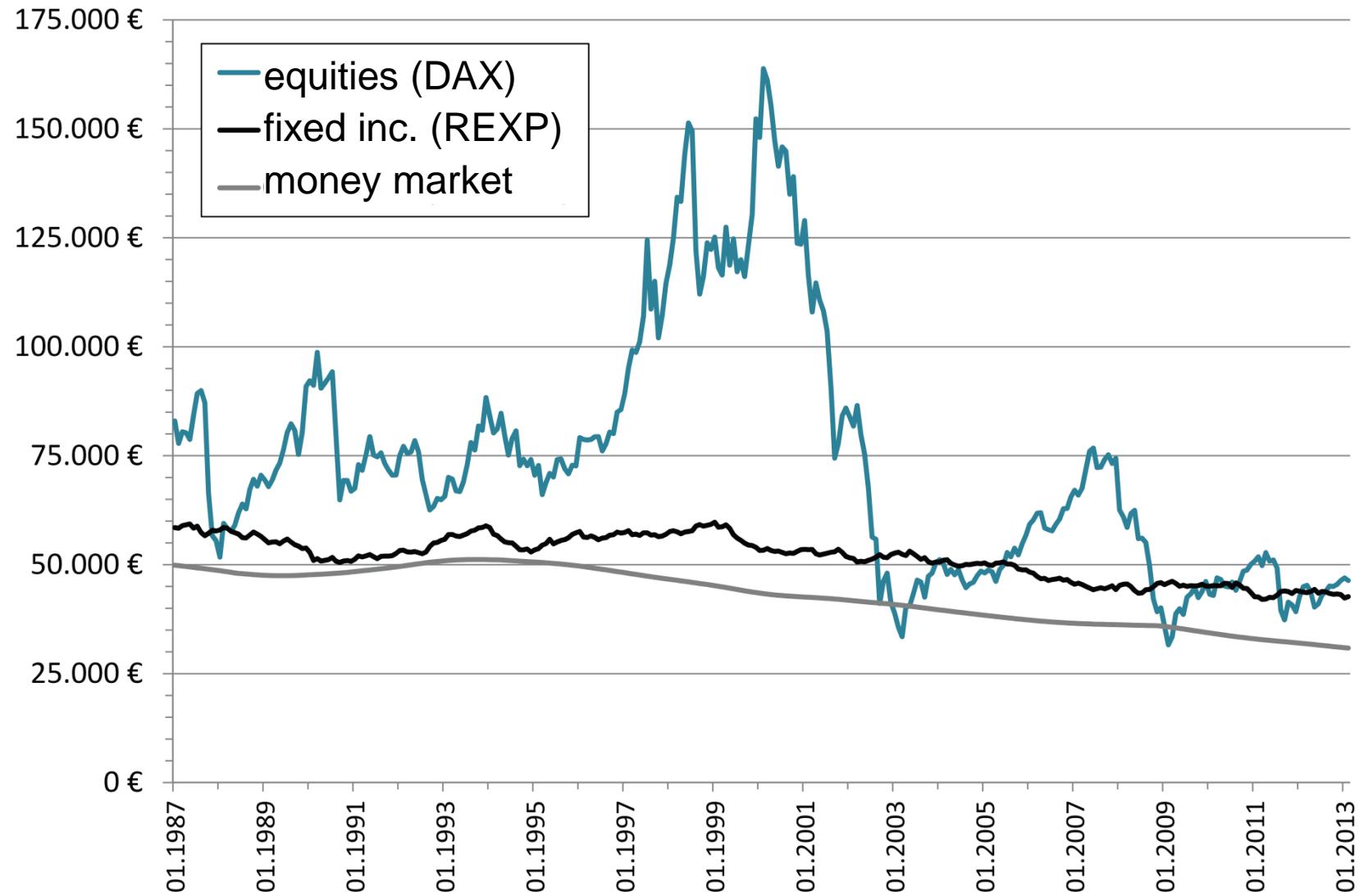
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20- year indiv. saving plans: accrued capital

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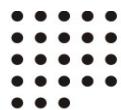
Individual vs. collective saving

individual saving
(mutual fund)

collective saving

collective reserve
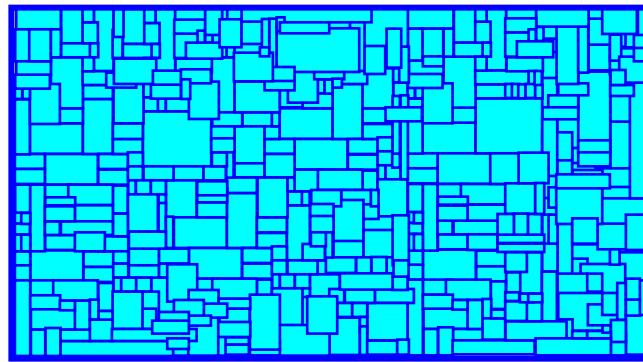
unit price follows exactly the
market value of assets
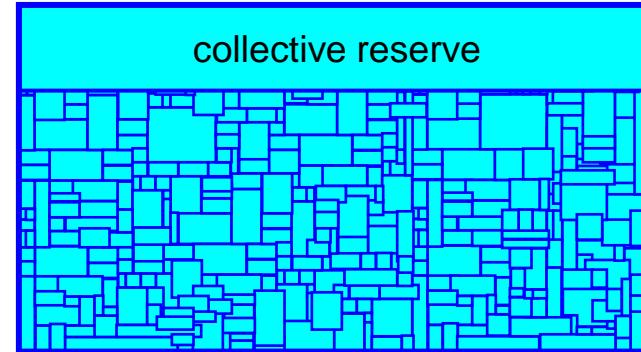
part of the assets is not
allocated to the individuals

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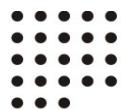
Balance sheet of collective saving model

Assets	Liabilities
	coll. reserve R_t
Portfolio P_t	Saving accounts (distributed assets) V_t

Capital market

saving contributions

$$P_t = R_t + V_t$$

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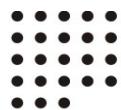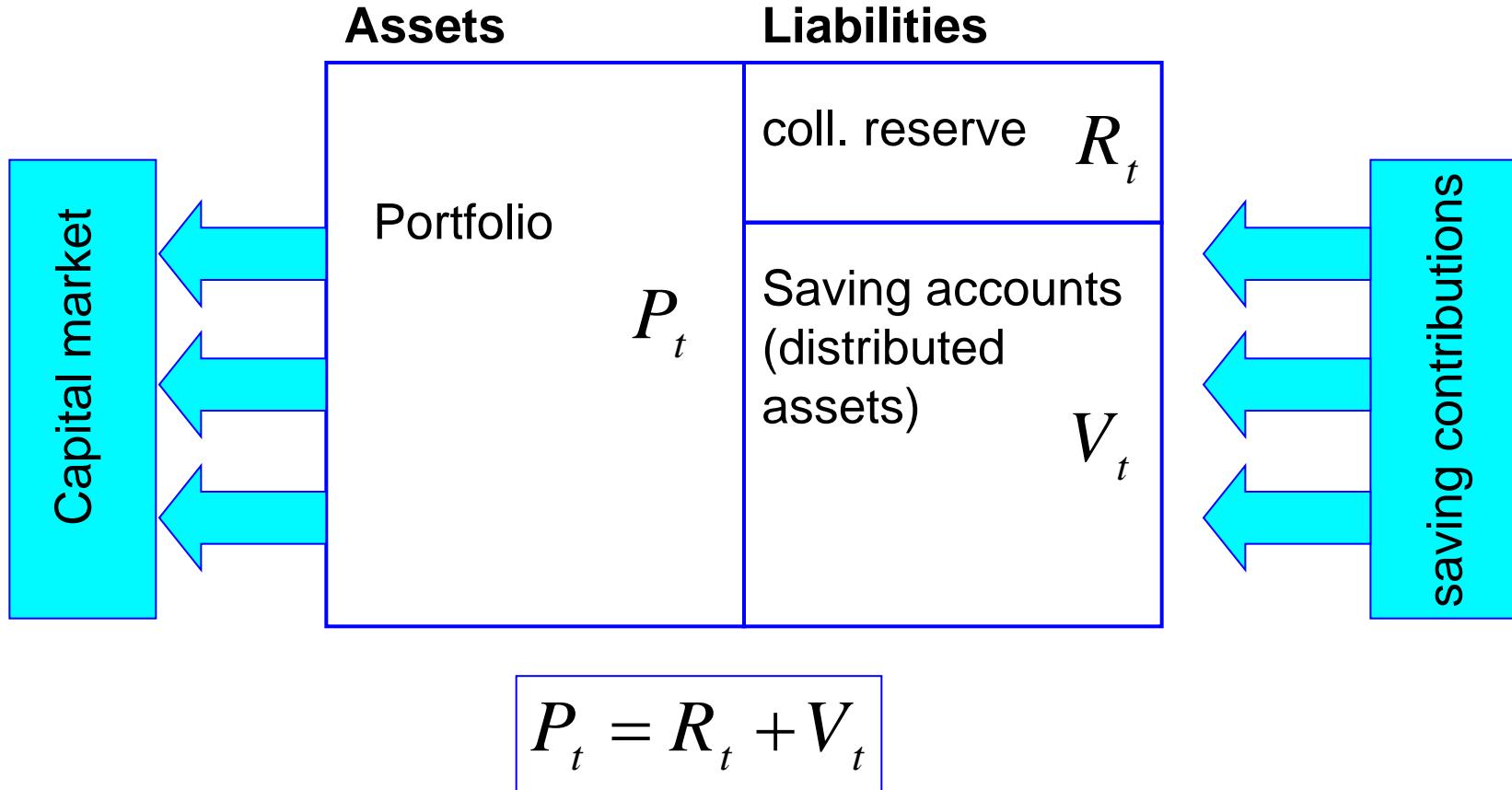
Intergenerational risk sharing
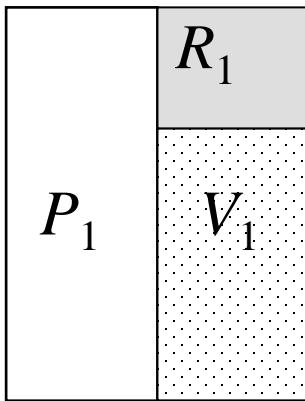
„bull markets"		„bear markets"
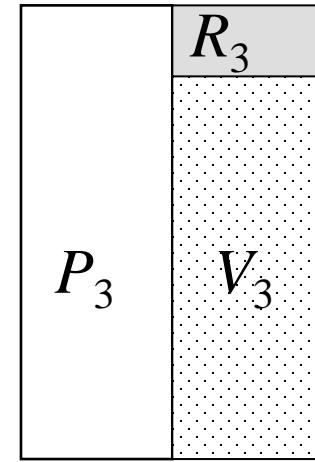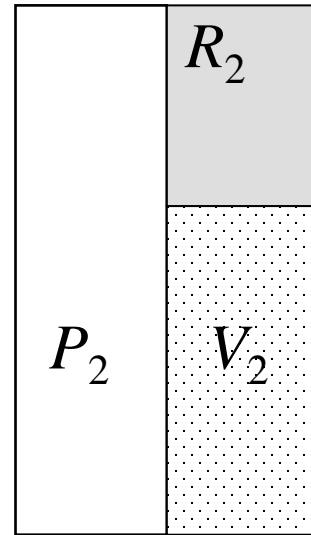
volatile market values are buffered into the collective reserve
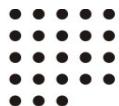
Asset liability - management

Assets **Liabilities**

Portfolio P_t	coll. reserve R_t
	Saving accounts (distributed assets) V_t

risk exposure (asset allokation) σ_t

„declaration" (profit participation) η_t

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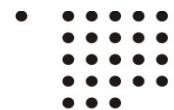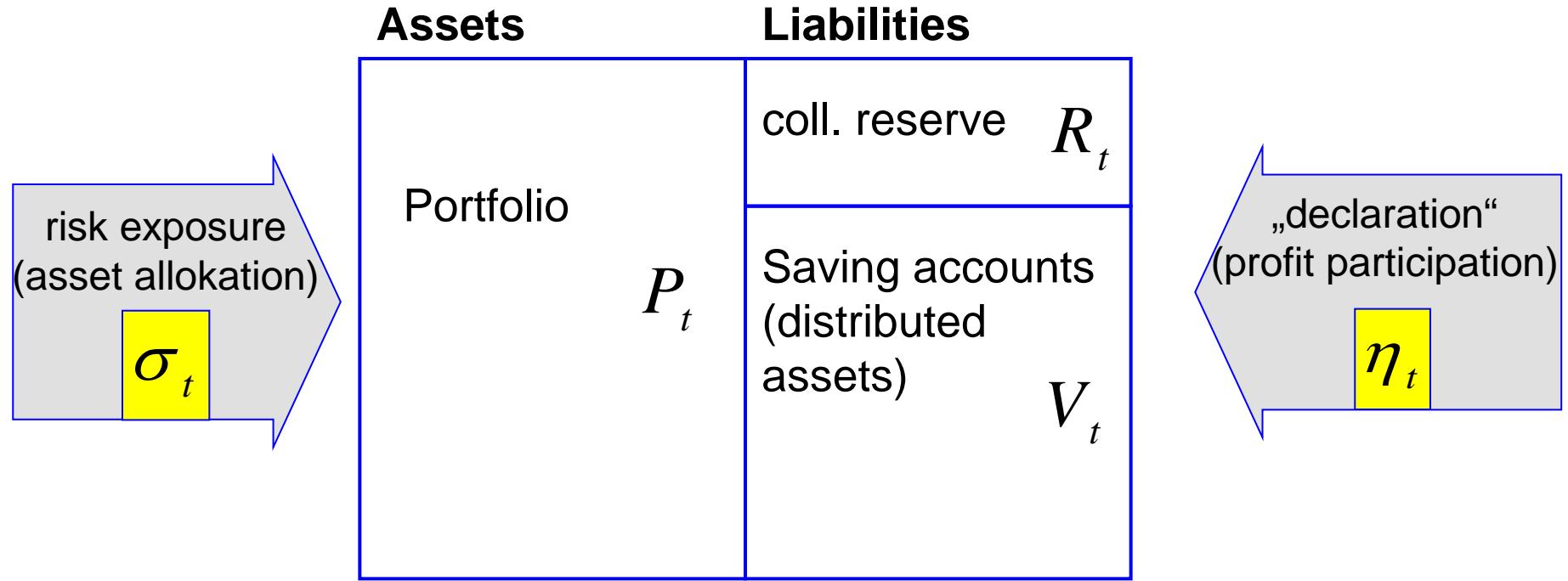
Asset liability - management

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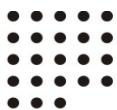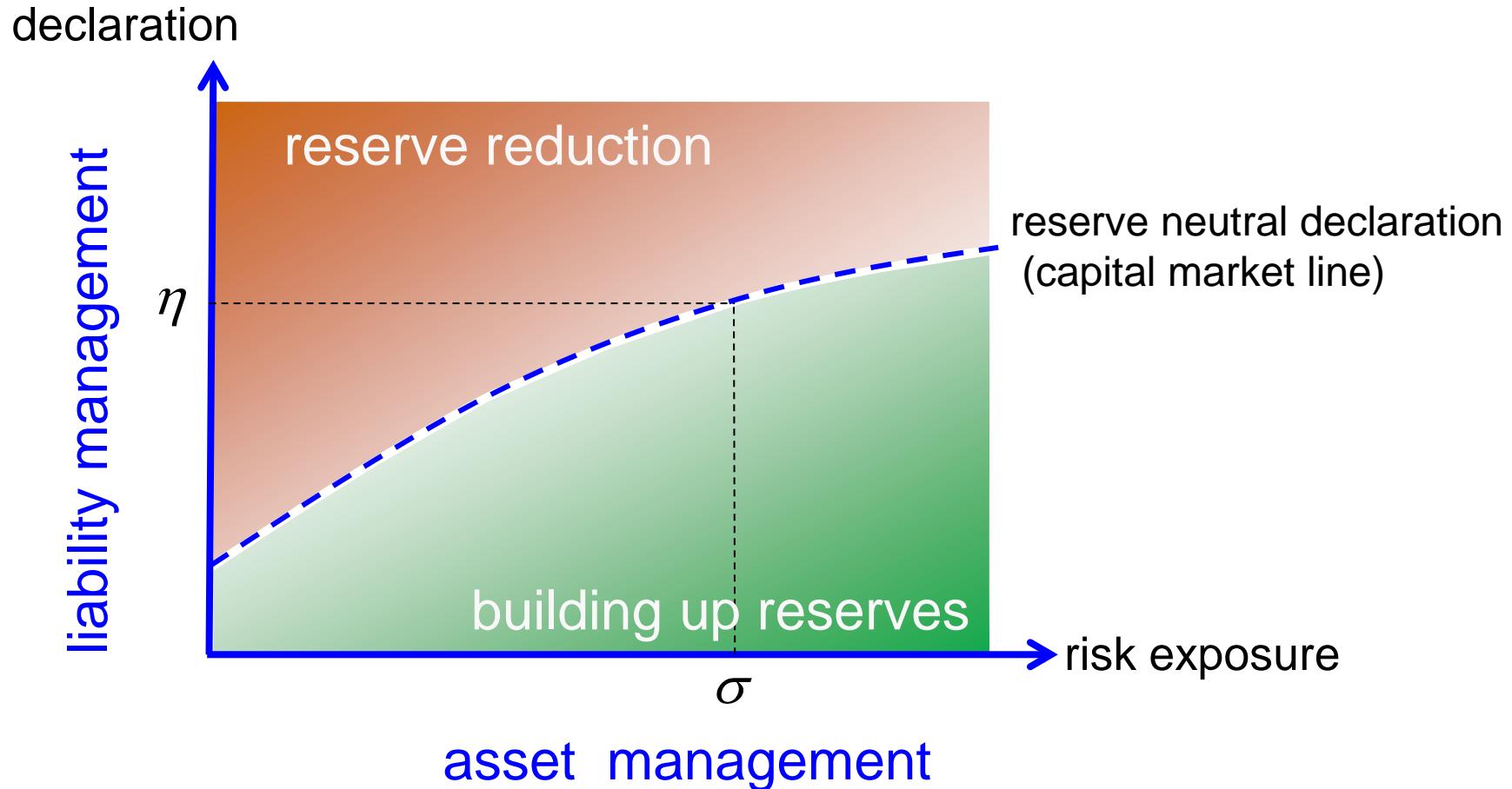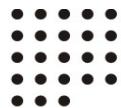
ALM-Model

Assets
$$\frac{dA(t)}{A(t)} = \left(\overline{\mu} + r_M\,\sigma(t)\right)dt + \sigma(t)dW_t$$

Liabilities
$$\frac{dV(t)}{V(t)} = \eta(t)\,dt$$

„control"
$$\hat{\rho}(t) := \ln\left(\frac{A(t)}{V(t)}\right) - \rho_{\text{target}}$$

ALM
$$\sigma(t) = \hat{\sigma} + a\,\hat{\rho}(t)$$
$$\eta(t) = \left(\overline{\mu} + r_M\sigma(t) - \tfrac{1}{2}\sigma^2(t)\right) + \theta\,\hat{\rho}(t)$$

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ALM-Model

$$A(t) = A_0 \, \exp\left(\int\limits_0^t \overline{\mu} + r_M \, \sigma(s) - \tfrac{1}{2}\sigma^2(s) \, ds + \int\limits_0^t \sigma(s) \, dW_s \right)$$

$$V(t) = V_0 \, \exp\left(\int\limits_0^t \eta(s) ds \right) = V_0 \, \exp\left(\int\limits_0^t \left(\overline{\mu} + r_M \sigma(t) - \tfrac{1}{2}\sigma^2(t) \right) + \theta \, \hat{\rho}(t) ds \right)$$

$$\hat{\rho}(t) = \ln\left(\frac{A(t)}{V(t)} \right) - \rho_{\text{target}} = \hat{\rho}_0 - \theta \int\limits_0^t \hat{\rho}(s) ds + \int\limits_0^t \left(\hat{\sigma} + a \, \hat{\rho}(s) \right) dW_s$$
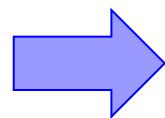
$$\Longrightarrow \quad d\hat{\rho}(t) = -\theta \, \hat{\rho}(t) \, dt + \left(\hat{\sigma} + a \, \hat{\rho}(t) \right) dW_t$$
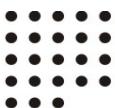
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Solution:

For $Z_t := \exp\left(aW_t - \frac{1}{2}a^2 t\right)$ we get

$$\sigma(t) = e^{-\theta t} \, Z_t \left(\sigma_0 + \theta \, \hat{\sigma} \int_0^t \frac{e^{\theta s}}{Z_s} ds \right)$$

$$\hat{\rho}(t) = \begin{cases} \dfrac{\hat{\sigma}}{a} \left(e^{-\theta t} \, Z_t \left(1 + \dfrac{a \, \hat{\rho}_0}{\hat{\sigma}} + \theta \int_0^t \dfrac{e^{\theta s}}{Z_s} ds \right) - 1 \right) & \text{for } a \neq 0 \\[4mm] e^{-\theta t} \left(\hat{\rho}_0 + \hat{\sigma} \int_0^t e^{\theta s} dW_s \right) & \text{for } a = 0 \end{cases}$$

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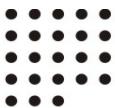
Limit results

For $\theta > 0,\ a \neq 0$:

$$\rho(t) \xrightarrow{\ \textit{in distribution}\ } \hat{\rho}_\infty$$

$$\sigma(t) \xrightarrow{\ \textit{in distribution}\ } \sigma_\infty$$

$$\eta(t) \xrightarrow{\ \textit{in distribution}\ } \eta_\infty$$

The limits are inverse gamma distributed or
closely related to the invers gamma distribution.

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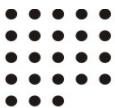
Collective saving ….

What is it good for?

What is the effect on the risk return profile?

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Individual vs. collective saving

Invest S_0 for T years

a) individual saving plan with const-mix-strategy (σ)

b) collective saving plan with reserve buffering $(\hat{\sigma}, a, \theta, \hat{\rho}_0)$

$$\frac{dA(t)}{A(t)} = \left(\bar{\mu} + r_M\,\sigma(t)\right)dt + \sigma(t)dW_t \qquad \bar{\mu} = 3\%, \quad r_M = 0.25$$

$$\sigma(t) = \sigma \ (const - mix)$$

$$\Rightarrow S_T = S_0 \exp\left(\left(\bar{\mu} + r_M\,\sigma - \tfrac{1}{2}\sigma^2\right)T + \sigma W_T\right)$$

$$\Rightarrow annual\ return = \frac{1}{T}\ln\left(\frac{S_T}{S_0}\right) = \bar{\mu} + r_M\,\sigma - \tfrac{1}{2}\sigma^2 + \sigma\frac{W_T}{T}$$

$$\Rightarrow risk := annualized\ stdev = \sigma$$

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risk-return profile (const-mix)
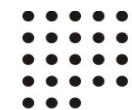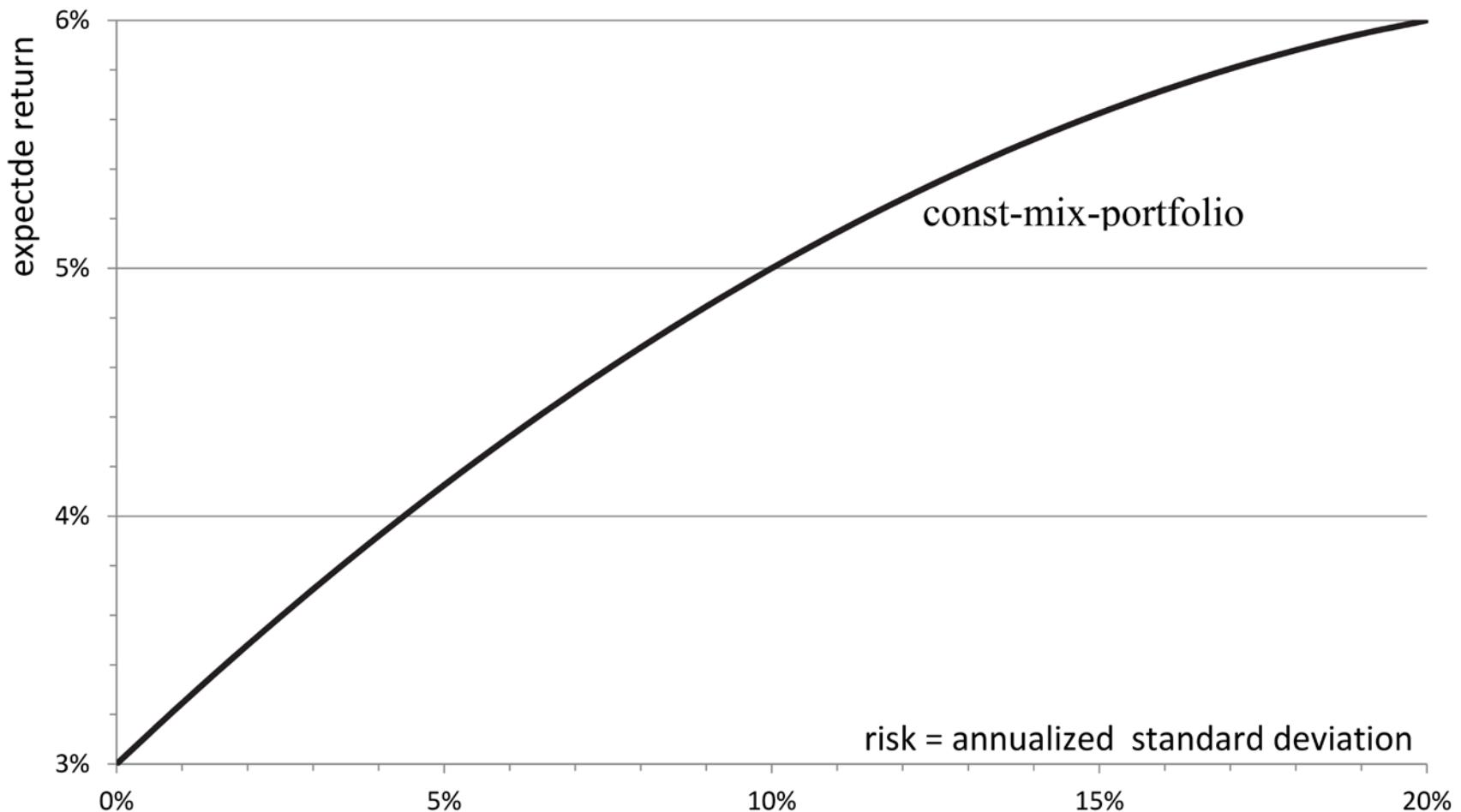
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risk return profiles cs

$$Parameters: a = 0, \quad \theta = 0.4, \quad \hat{\rho}_0 = 0$$

$$\bar{\eta}(T) := \frac{1}{T} \int_0^T \eta(t)dt$$

$$StdDev(\bar{\eta}(T)) := \hat{\sigma} \sqrt{1 - \frac{(1 - e^{-\theta T})(3 - e^{-\theta T})}{2\theta T}}$$

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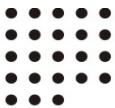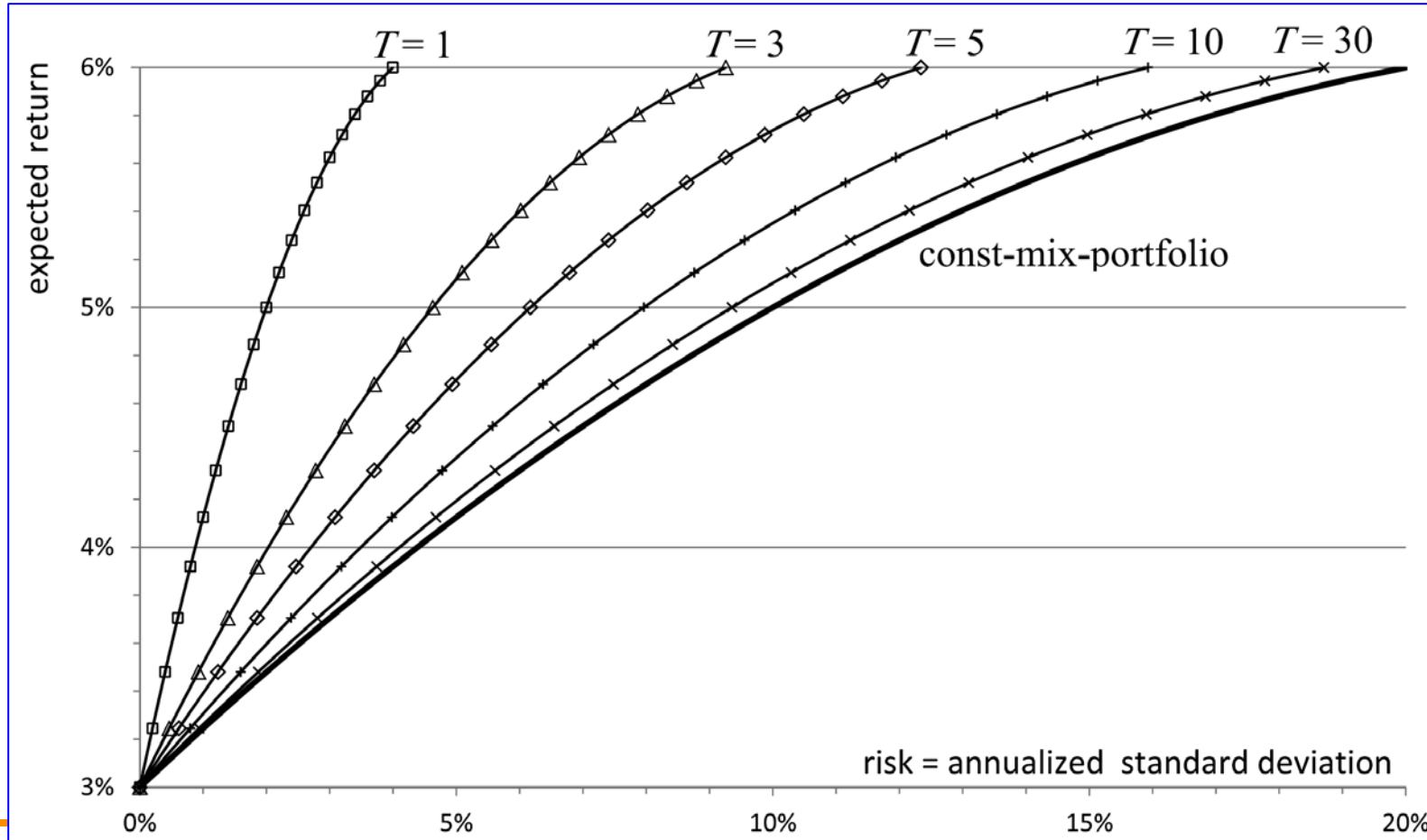
Idea: risk = path volatility

individual saving

collective saving

months

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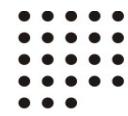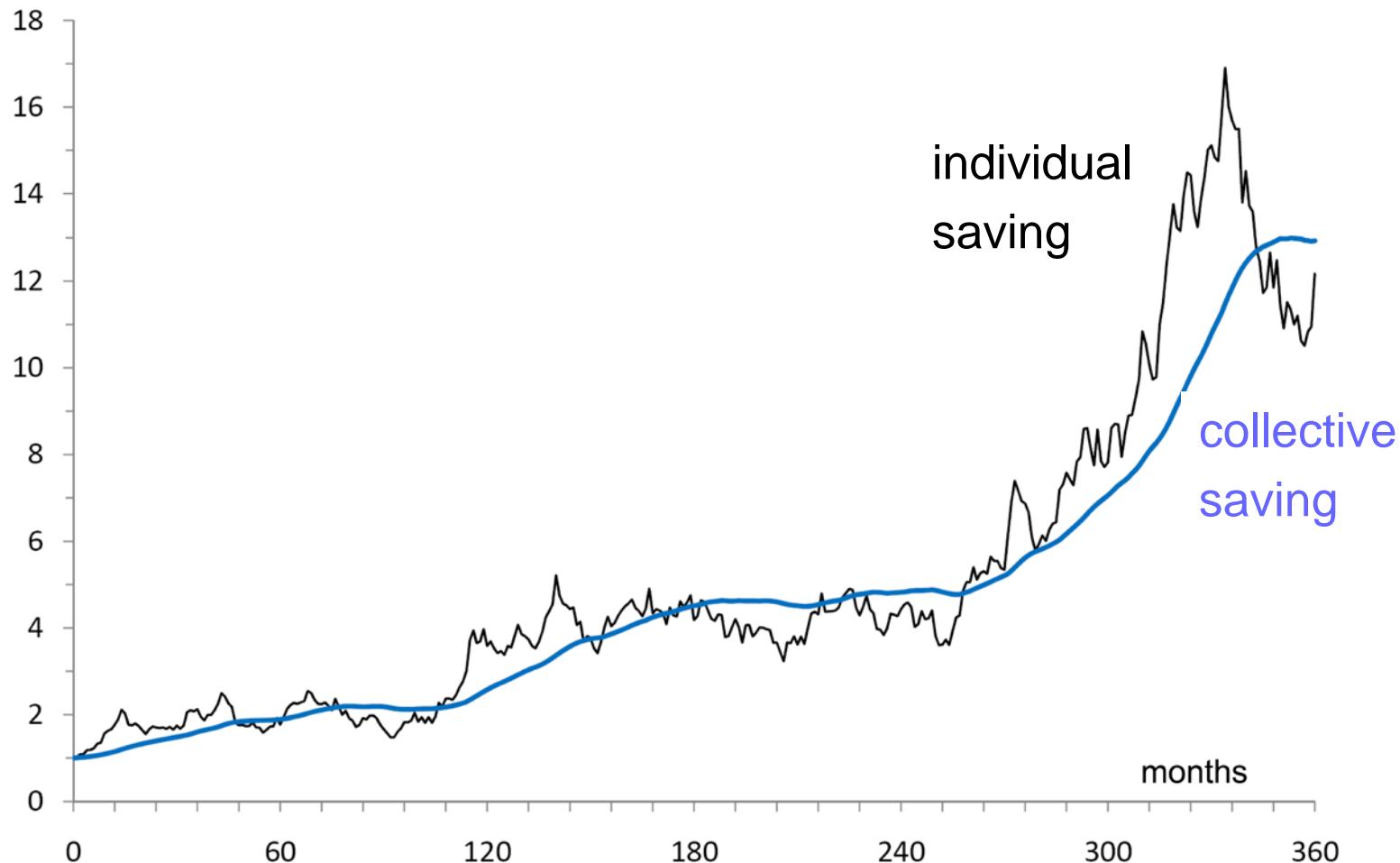
Risk-Return-Profile: **Path volatility**
(lump-sum investment, T = 20 years, 5000 Monte Carlo simulations)
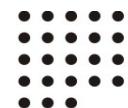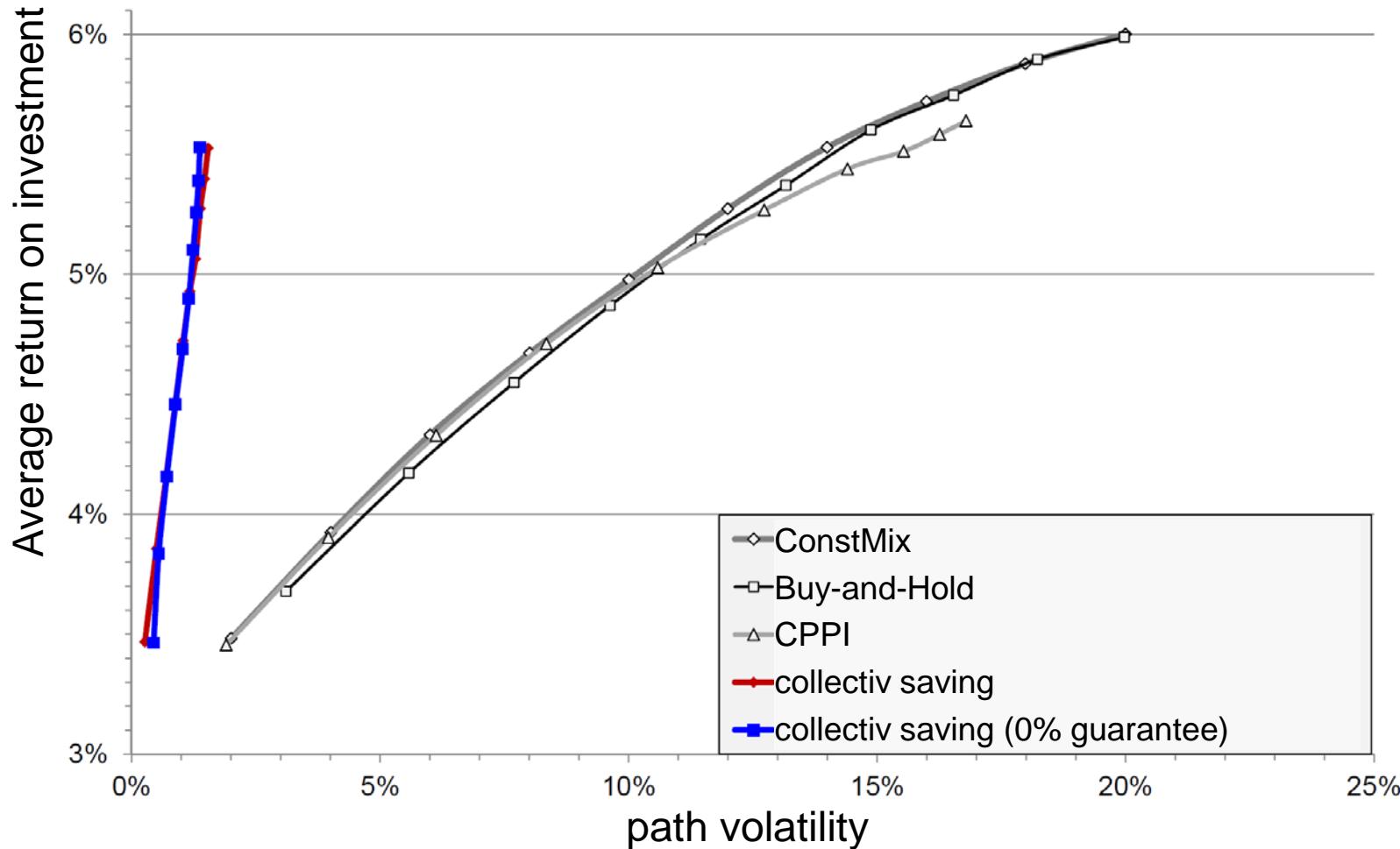
Risk-Return-Profile: **Maximum Drawdown**
(lump-sum investment, T = 20 years, 5000 Monte Carlo simulations)
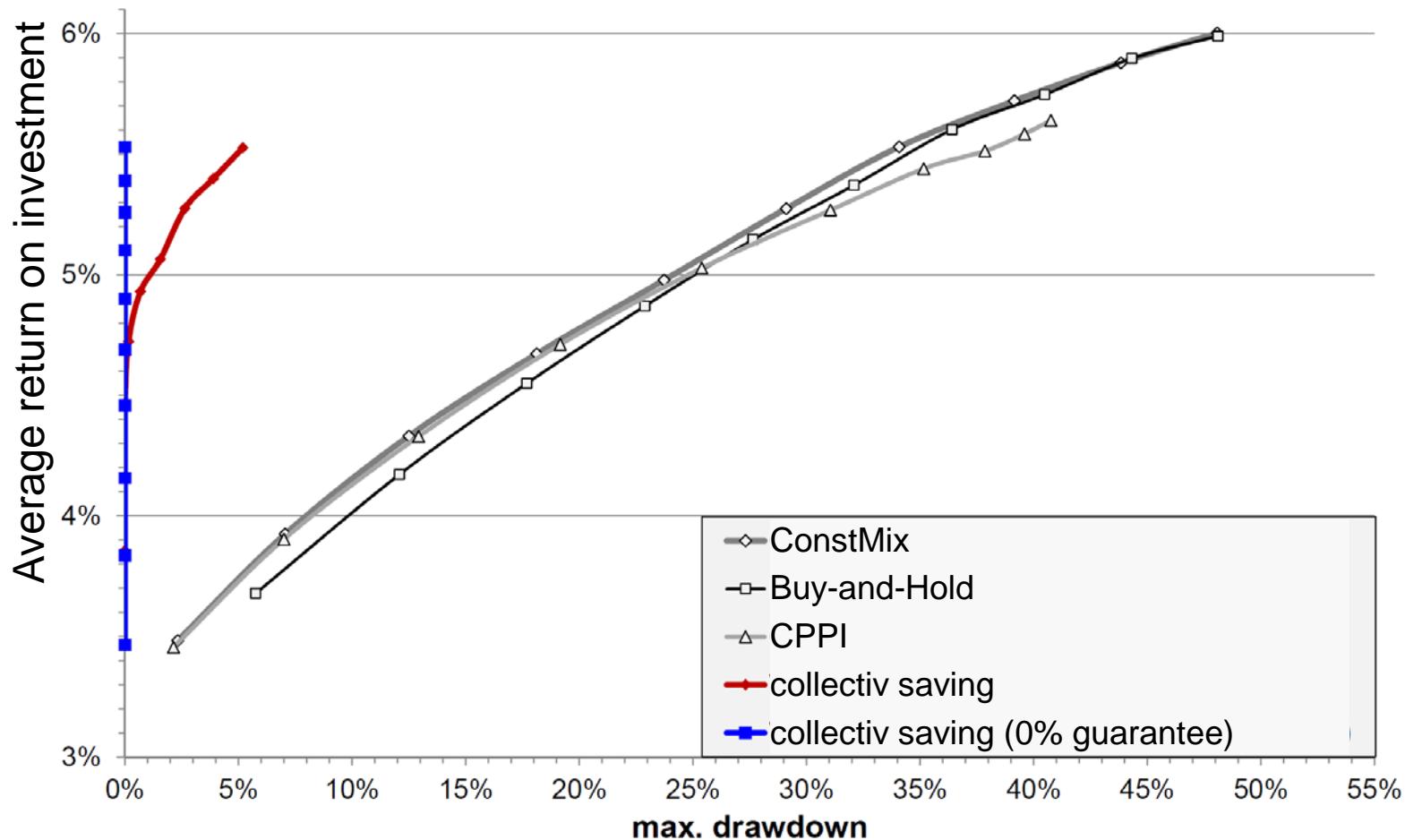
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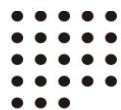
ALM- strategy

- Fix the **strategic risk exposure**
  (e.g. 50% stocks, 50% fixed income)

- Fix the **strategic reserve ratio** (e.g. 20%)

- Each month (year) determine the
  reserve cushion:= actual *minus* strategic reserve

- Decide on **tactical ALM**:

  reserve cushion > 0: declaration and risk exposure up
  reserve cushion < 0: declaration and risk exposure down

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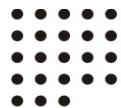
Backtesting 02.1967 – 03.2013

2 asset classes: equities and fixed income with proxies:

- DAX (German stock market performance index)
- REXP (Performance index of synthetic portfolio of German govies, ∅ time-to-maturity=5.5 years)

Assumptions/ ALM strategy

- strategic asset allocation: 50% shares/ 50% fixed income

- strategic/initial reserve ratio: 20%

- monthly adjustment of tatical ALM
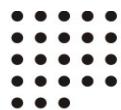
DAX/ REXP/ Money market (31.1.1967=1)
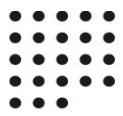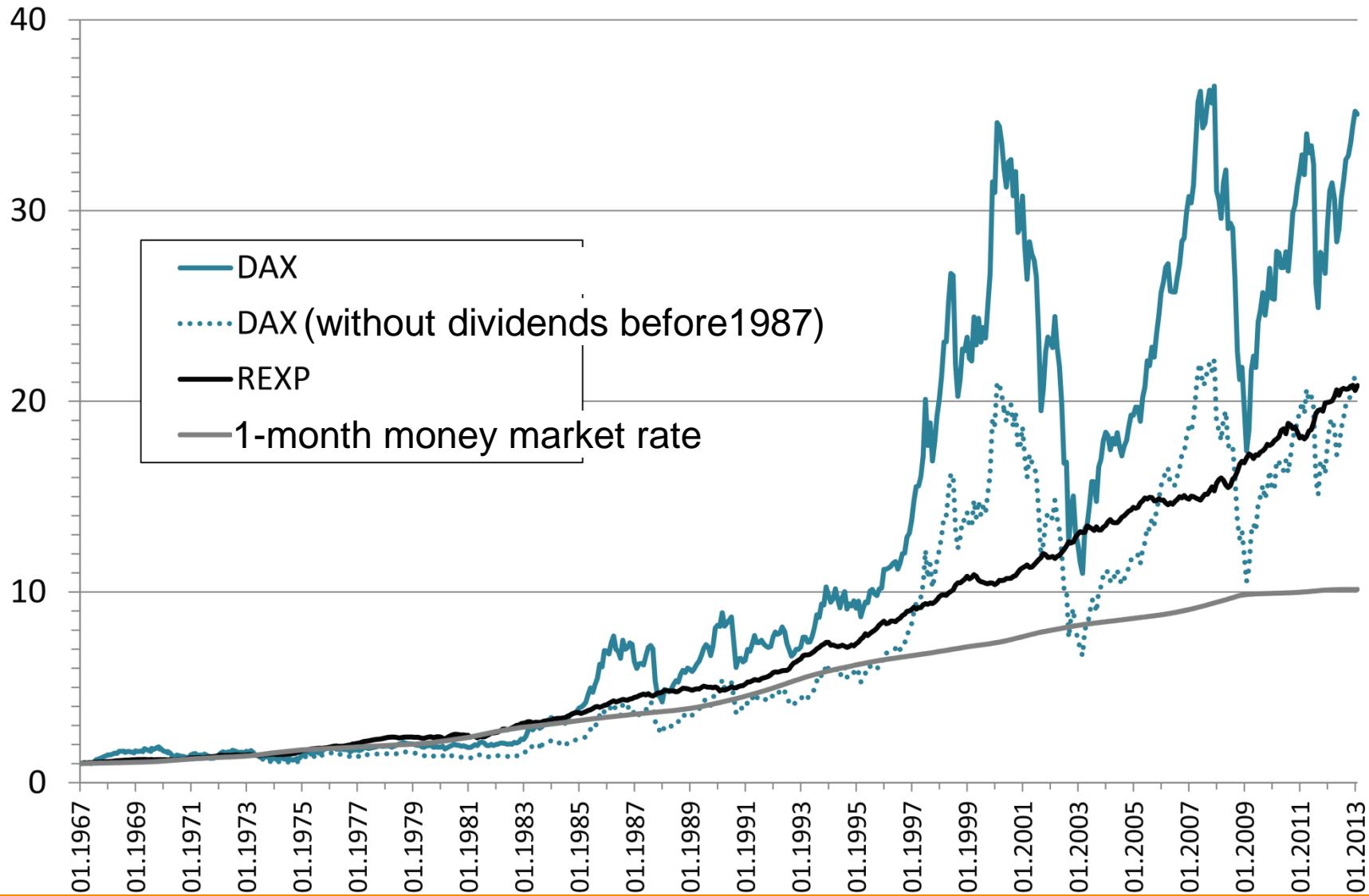
Backtesting 02.1967 – 03.2013

Basic saving plan: Save 100€ per month for 20 year.

$\Rightarrow$ 314 samples for backtesting.

We compare :

- individual saving (100% equities/ DAX)

- individual saving (100% fixed income/ REXP)

- individual saving (100% money market funds/ …)

- collective saving

no administration charge/ no transactions expenses
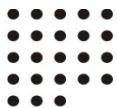
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20- year indiv. saving plans: accrued capital

Legend:
- equities (DAX)
- fixed inc. (REXP)
- money market

20- year indiv. saving plans: annualized return

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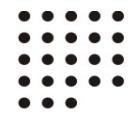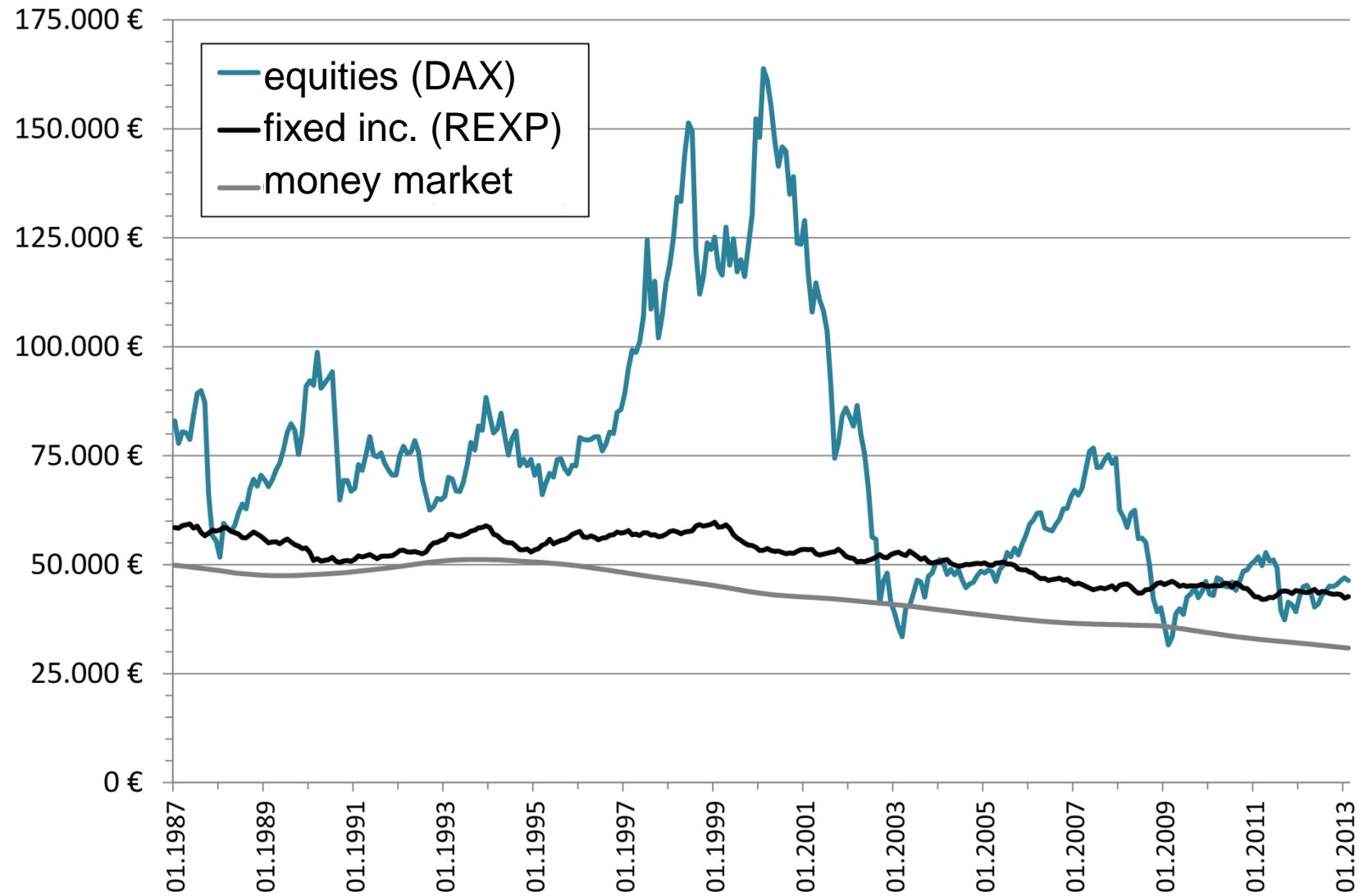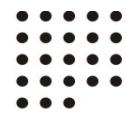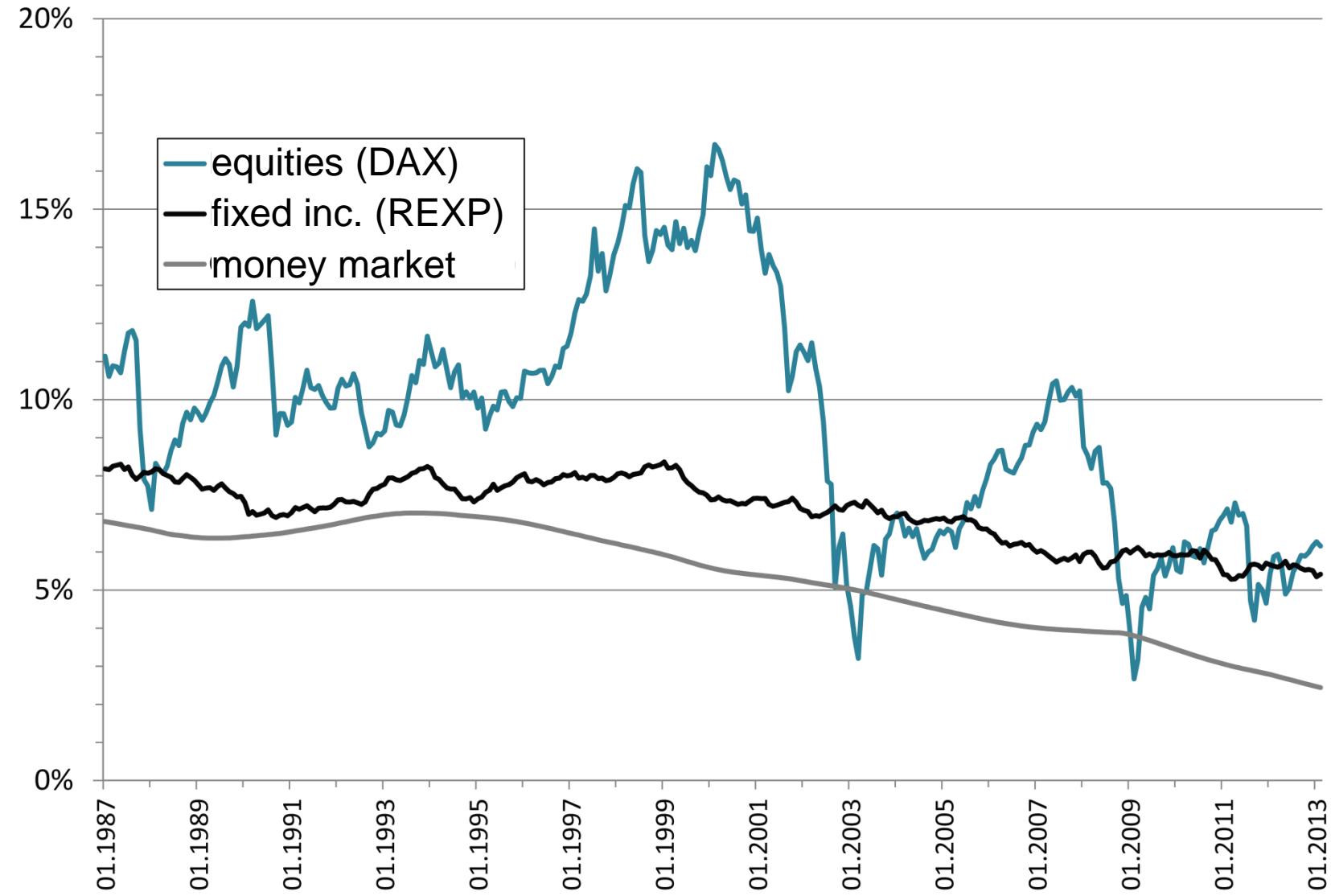
Collective saving
Initial portfolio (Febr 1962):

Assets	Liabilities
Portfolio: 50% equities 50% fixed inc.	coll. reserve: 20%
	Saving accounts (distributed assets): 80%

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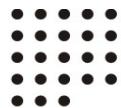
reserve ratio
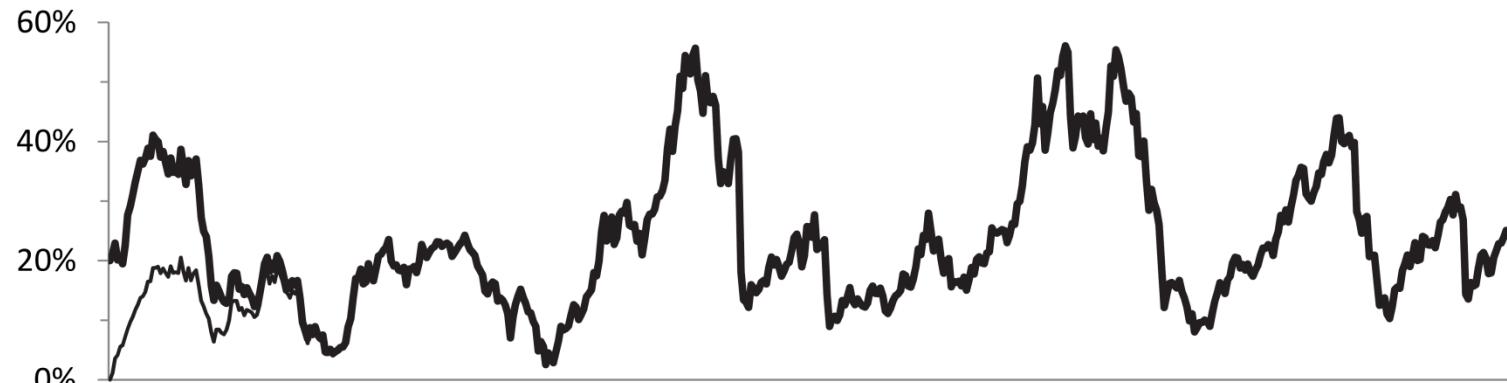
risk exposure (share ratio)

declaration (per month)

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20- year saving plans: accrued capital

equities (DAX)
fixed inc. (REXP)
money market
coll. saving (initial res.=20%)
coll. saving (initial res.= 0%)

163.803 €

31.632 €

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20- year saving plans: annualized return

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Special Sample: 03.1989-02.2009 (*worst case*)

accrued capital

- equities (DAX)
- fixed inc. (REXP)
- coll. saving

64.496 €

68.873 €

45.851 €

31.632 €

70.000 €
60.000 €
50.000 €
40.000 €
30.000 €
20.000 €
10.000 €
0 €

1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009

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Special Sample: 03.1980-02.2000 (*best case*)

accrued capital

- equities (DAX)
- fixed inc. (REXP)
- coll. saving

163.803 €

83.527 €

53.309 €

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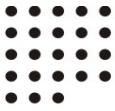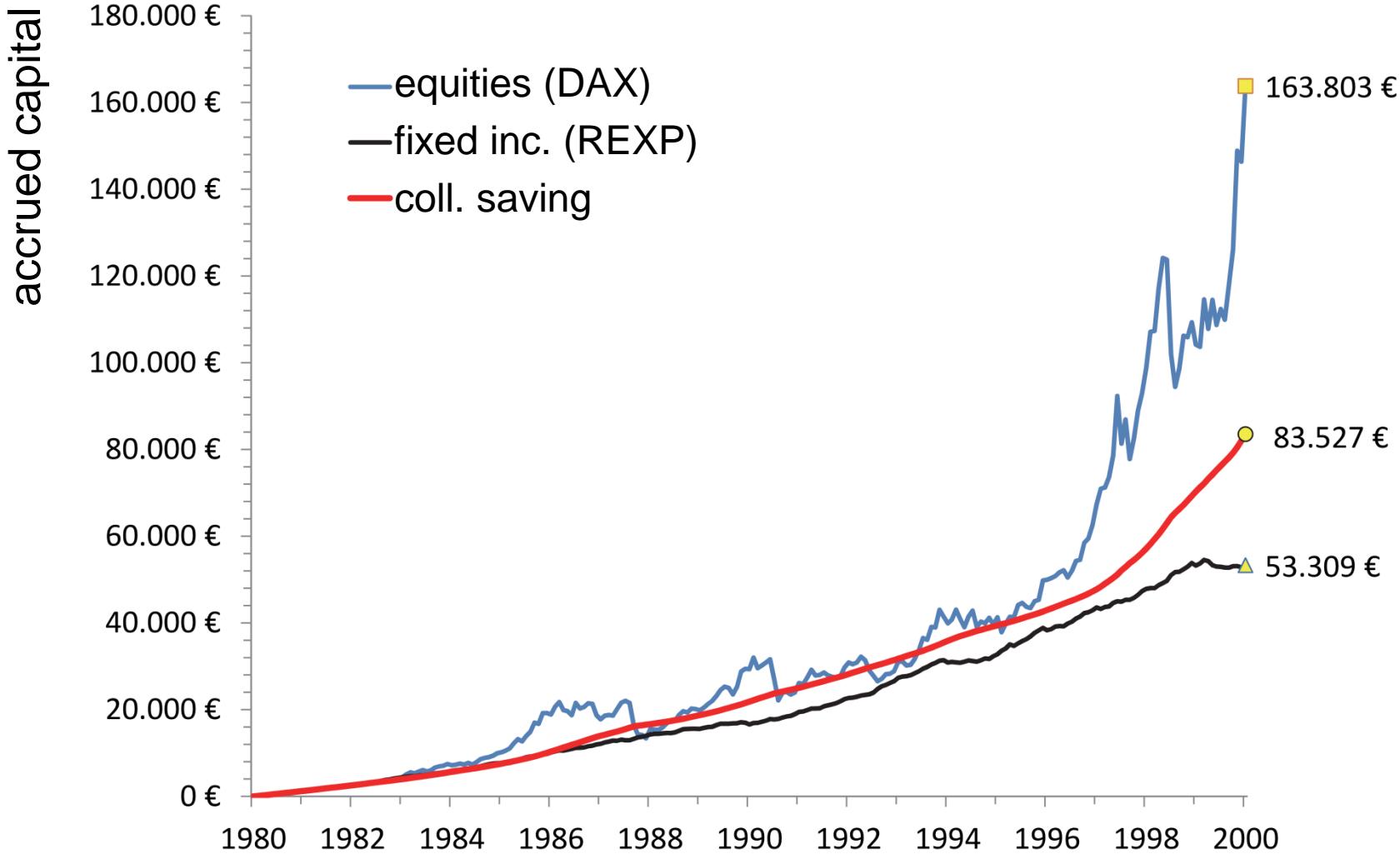
Annualized return on saving rates
(Statistical analysis of 314 samples)

	fixed income (REXP)	equities (DAX)	collective saving
20-year saving plan			
Average	7.23%	9.29%	9.52%
Minimum	5.87%	5.49%	8.43%
Maximum	8.31%	16.01%	11.52%
Standard Deviation	0.61%	2.48%	0.90%

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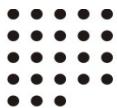
Pros and Cons

+ fair risk sharing between generations of savers

- risk sharing produces "loosers" and "winners"

+ allows for a high proportion of investment in real asset

+ improved risk return profile

+ rewards contractual loyality

- requires contractual loyality (no premature cash out)

- requires an initial reserve (!!!!)

+ requires no payments to shareholders

- grants no guarantees from outside

+ high degree of transparency possible

- no regulatory framework so far
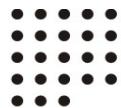
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Overview

- Economic background/ interest rate environment/ risk premium

- What does it mean „collective saving"?

- Results from theory

- Results from backtesting

- Concluding remarks

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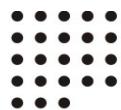
Concluding remarks

The idea behind collective saving is not new! We find some elements in the traditional with-profit life insurance products.

- traditional with-profit policies involve year-to-year interest rate guarantees
  $\Rightarrow$ low share ratio $\Rightarrow$ low/no *real* return

- most with-profit products are quite opaque (amalgamation of policy holder and shareholder interests)

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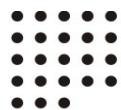
Concluding remarks

- capital funded old age provision requires a high proportion of investment into real assets

- but investments into shares or real estates are „punished" in the Solvency 2 regime

- intergenerational risk transfer of capital market risks is a proper answer to the mark-to-market mania.
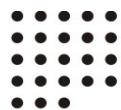
Thank you for your kind attention!

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For more details …

- Albrecht, Peter: *Erbringen Lebensversicherungsunternehmen im Rahmen ihrer Kapitalanlagetätigkeit eine Leistung - und welchen Nutzen ist diese für die Versicherungskunden?*, Mannheimer Manuskripte zur Risikotheorie, Portfoliomanagement und Versicherungswirtschaft, Nr. 124, Mannheim 10/ 2000.

- O.G.: *Über die Fähigkeit eines Lebensversicherers Kapitalmarktrisiken zu transformieren,* Blätter der DGVFM 26 (2), 207–227.

- O.G.: *Pension saving schemes with return smoothing mechanism*, in: Insurance Mathematics and Economics 53 (2013), 678-689.

- O.G. : *Sparprozesse mit kollektivem Risikoausgleich - Simulationsrechnungen*; Institut für Versicherungswesen, Forschungsstelle FaRis. Working Paper 07/2013; http://opus.bsz-bw.de/fhk/volltexte/2013/42/

- O.G. : *Sparprozesse mit kollektivem Risikoausgleich - Backtesting*; Institut für Versicherungswesen, Forschungsstelle FaRis. Working Paper 05/2012; http://opus.bsz-bw.de/fhk/volltexte/2012/12/

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