Household Finance Problems and Numerical Methods

In conclusion: results on optimal mortgages can be found by including stochastic interest & labor income

- A Fixed Rate Mortgage (FRM), is found to be the optimal choice for an investor with constant Labor Income and infinite risk-aversion
- The Adjustable Rate Mortgage (ARM) with short-rate as interest, is found to be optimal only if the market price on interest risk is zero.

In conclusion: Even simple extensions cannot be solved analytically & must be attacked by numerical methods

Numerical Methods:

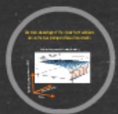
- Discretizing the problem and solve w/ stochastic programming
- Monte-Carlo Methods
- Finite difference discretization of the continuous set-up
- Finite Element Method in the continuous set-up

In conclusion: many simple Household Finance Problems can be solved analytically by the HJB-equation

However, limitations often occur, e.g.:

- Controls continuous in time
- Time-homogenous utility function
- Conditions on smoothness and growth
- Complete markets

Household Finance Problems and Numerical Methods



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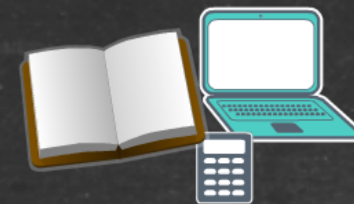
How do we optimally manage our Finances?



- Labor and Education

- Money and Investments

- Health and Insurance

- Housing and Mortgages

• Money and Investments

Prezi

When the market is std. B/S:

$$dB(t) = rB(t)dt$$
$$dS(t) = \alpha S(t)dt + \sigma S(t)dW(t)$$

Optimizing Expected Utility of Terminal Wealth:

Determine

$$V(t,x) = \sup_{\pi} E_{t,x}[u(X_T^{\pi})]$$

Non-stochastic

HJB-equation to solve:

$$V_t + \inf_{\pi}\{(r + \pi(\alpha - r))xV_x + \frac{1}{2}\sigma^2\pi^2x^2V_{xx}\} = 0$$

$$V(T,x) = u(x)$$

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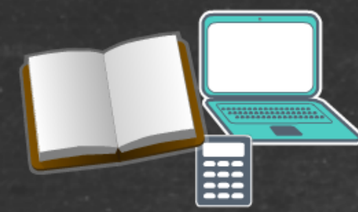

- Labor and Education

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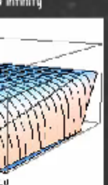
manage our Fin

-form solutions,
of the results

infinity

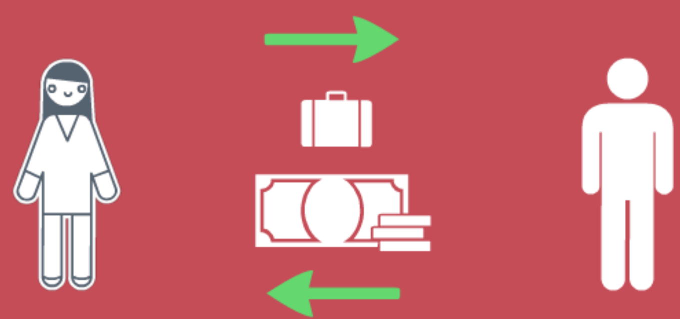


• Housing and Mortgages

• Health ar

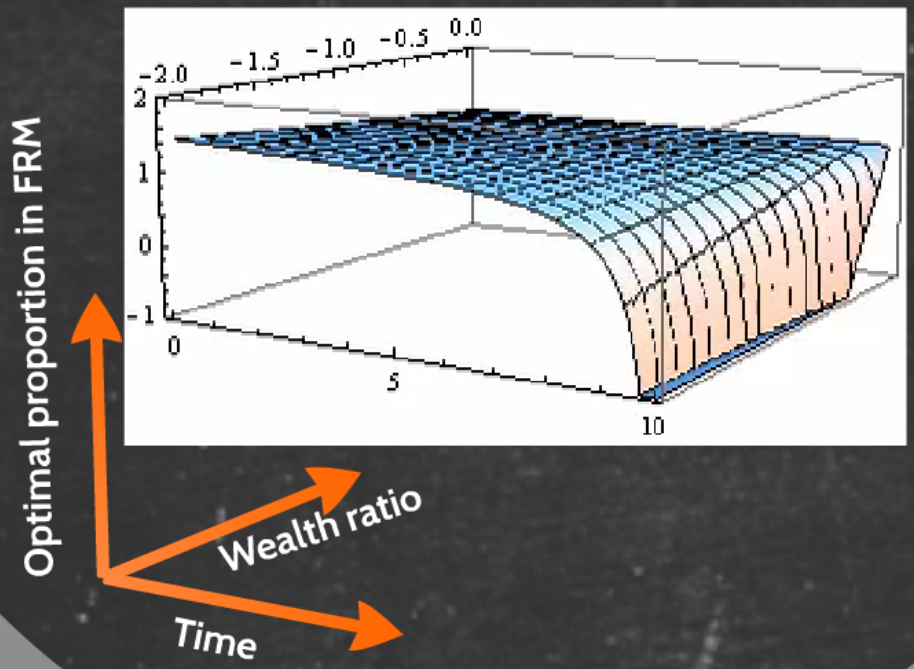
Prezi

For closed-form solutions, Labor-income must behave "as if" it were a financial asset



The main advantage of the closed-form solutions, lies in the nice interpretation of the results

Risk-aversion parameter tending to infinity



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Prezi

Further extension could be owning a house as financial asset

If housesale is a 0-1 decision, the solution is a stopping time

Optimizing Expected Utility of Terminal Wealth:

$$V(t,x,h) = \sup_{\tau} E_{t,x}[G(\tau, X(\tau) + H(\tau))]$$

Variational inequalities to solve:

$$V_t + \alpha h V_h + \frac{1}{2}\sigma^2 h^2 V_{hh} \leq 0$$

Cannot be solved analytically on finite Horizon

$$V(t,x,h) \geq G(t, x+h)$$

$$\tau^* = \inf\{t : V(t, X(t), H(t)) = G(t, X(t) + H(t))\}$$

When the market is B/S-like:

$$dX(t) = rX(t)dt$$

$$dH(t) = \alpha H(t)dt + \sigma H(t)dW(t)$$

Prezi

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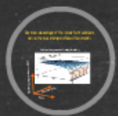

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