A Stylized Approach to the Role of Housing Liquidation Options in Optimal Consumption among Retirees

26th Annual Colloquium of Pension and Retirement Research

3rd of July 2018

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Does not want to financially burden her children

Wants to live healthier and be able to afford health care to see her grandchildren grow

Andrea Ryne, Age 65

Wants to stay in her own house

Wants to maintain her current lifestyle

$500,000

Andrea Ryne, Age 65

$100,000

How to live it up in retirement, without burning through savings?

My husband and I are planning to retire this year and want to enjoy retirement. We do not want to skimp on simple pleasures and die with lots of money in the bank. But we also don't want to run through our savings too soon. So how do we calculate withdrawals from our nest egg to spend as much as possible of our assets before we shuffle off this mortal coil? --E.S.

- http://money.cnn.com/2018/01/10/retirement/retirement-spending/index.html

Research Overview

- Use GAUSS to create a program to calculate optimal consumption by including:
  - housing liquidation options:
    - rent
    - sell and move to a different house
    - stay in current house
  - Health, income, and house price states
  - bequest intentions
- Also account for *housing liquidation transaction cost, depreciation, maintenance, current house and rent prices, and expected future house price*

Why is this Important?

We have limited wealth and income

Uncertainties

The major asset held in retirement is housing (Poterba et al. 2011)

Research Contribution

Recommends a solution to maximise utility:

1. Calculates optimal consumption, health and housing spending
2. Identifies the best housing liquidation scenario given shocks in income, health, and housing prices

Benefits:

Individuals: retirement planning and awareness of housing liquidation options

Private sector: guideline for retirement product consideration

Government: insight for pension and retirement support (especially in housing and health)

Research Questions

1. How does (optimal) consumption vary across retirees' income, asset, and health states?
2. How are these choices affected by housing liquidation options?
3. Under what conditions is it optimal for retirees to liquidate housing?

Literature

- Yogo (2016, JME): used numerical dynamic programming to solve life-cycle model reporting optimal consumption and portfolio choice (housing, stocks, and bonds) as a function of health status
- Extend this model by incorporating housing liquidation scenarios' effect on consumption (non-health, health, and housing)
- Also consider income and house price uncertainties

Methodology

- Stylized programming of the utility function of consumption, health expenditure and housing cost
- Use von-Neumann-Morgensten logarithmic Utility Function (1953)
- $u(chz) = \alpha_1 \ln(c) + \alpha_2 \ln(Hexp) + \alpha_3 \ln(size) + \beta \ln(Bequest + 10000)$
- $10,000 is chosen to capture the utility of the bequest without compromising the utility maximisation function.
- Applied to all the possible housing scenarios to achieve their corresponding Lagrangian equation and Karush-Kuhn-Tucker (KKT) conditions

Methodology

- Current assumptions:

1. Liquidity constraint (Inability to borrow) (Finkelstein et al. 2012; JEEA)
2. Individuals are rational and aim for maximum total utility (Samuelson, 1938)
3. Marginal utility of consumption declines with bad health (Finkelstein et al. 2012; JEEA)
4. Marginal utility of housing options depend on health status (Yogo, 2016; JME)

Housing Options

RENT or SELL/RENT

A. Choose rental property size

B. Save for future or for bequest

SELL/BUY

A. Sell existing property

B. Choose new property size (downsize/upsize)

C. Save for future or for bequest

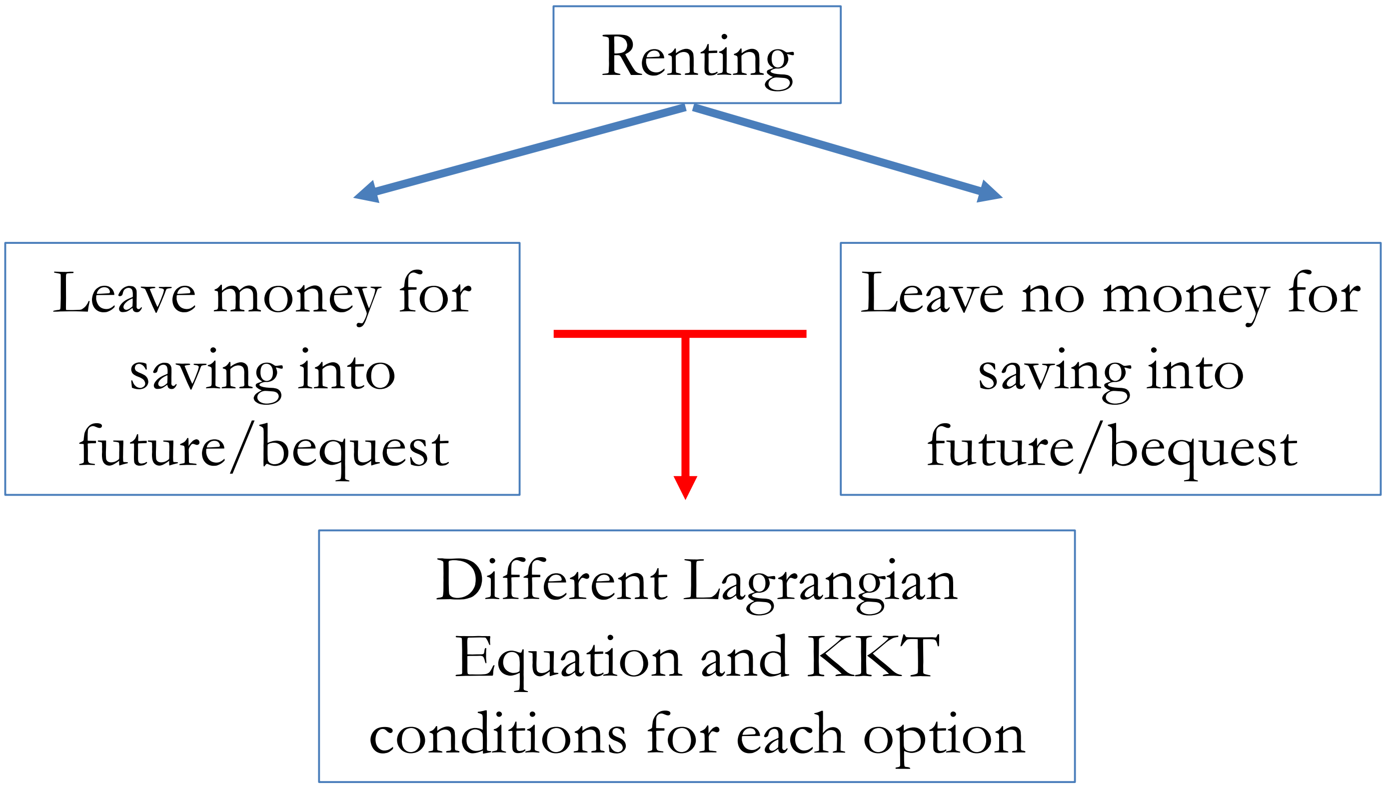
STAY

A. Stay in current house

B. Choose to do maintenance or not

C. Save for future or for bequest

Programming for Renting Scenario



Lagrangian Equation for Renting

- $u(chz) = \alpha_1 \ln(c) + \alpha_2 \ln(HExp) + \alpha_3 \ln(size) + \beta \ln(10000 + Bequest) + \lambda_1[money - c - HExp - size * P_{rent} - Bequest]$

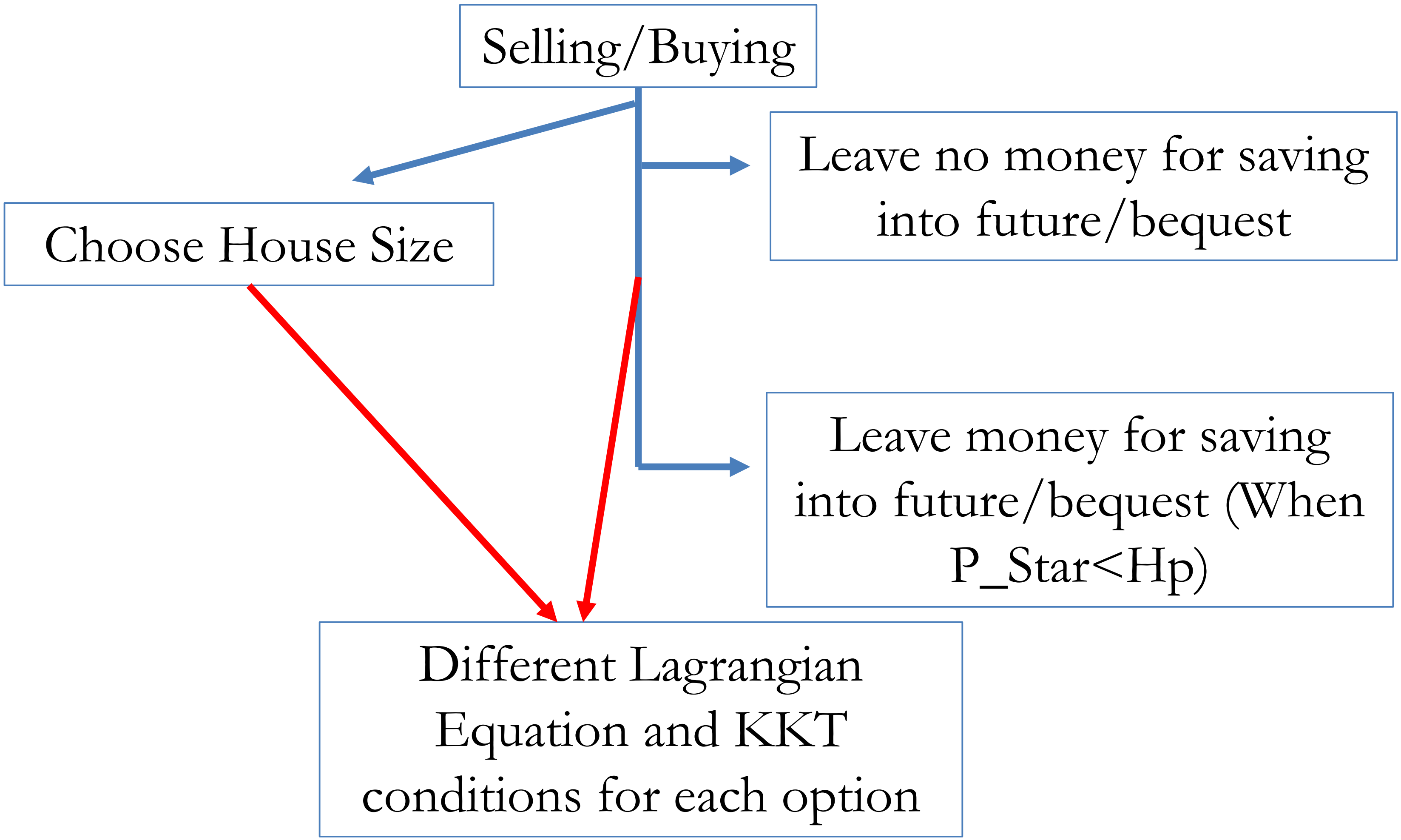
where

$$P_{rent} = \left(Hp - \left(ExpP * \frac{1-\delta}{1+interest}\right) * n\right)$$

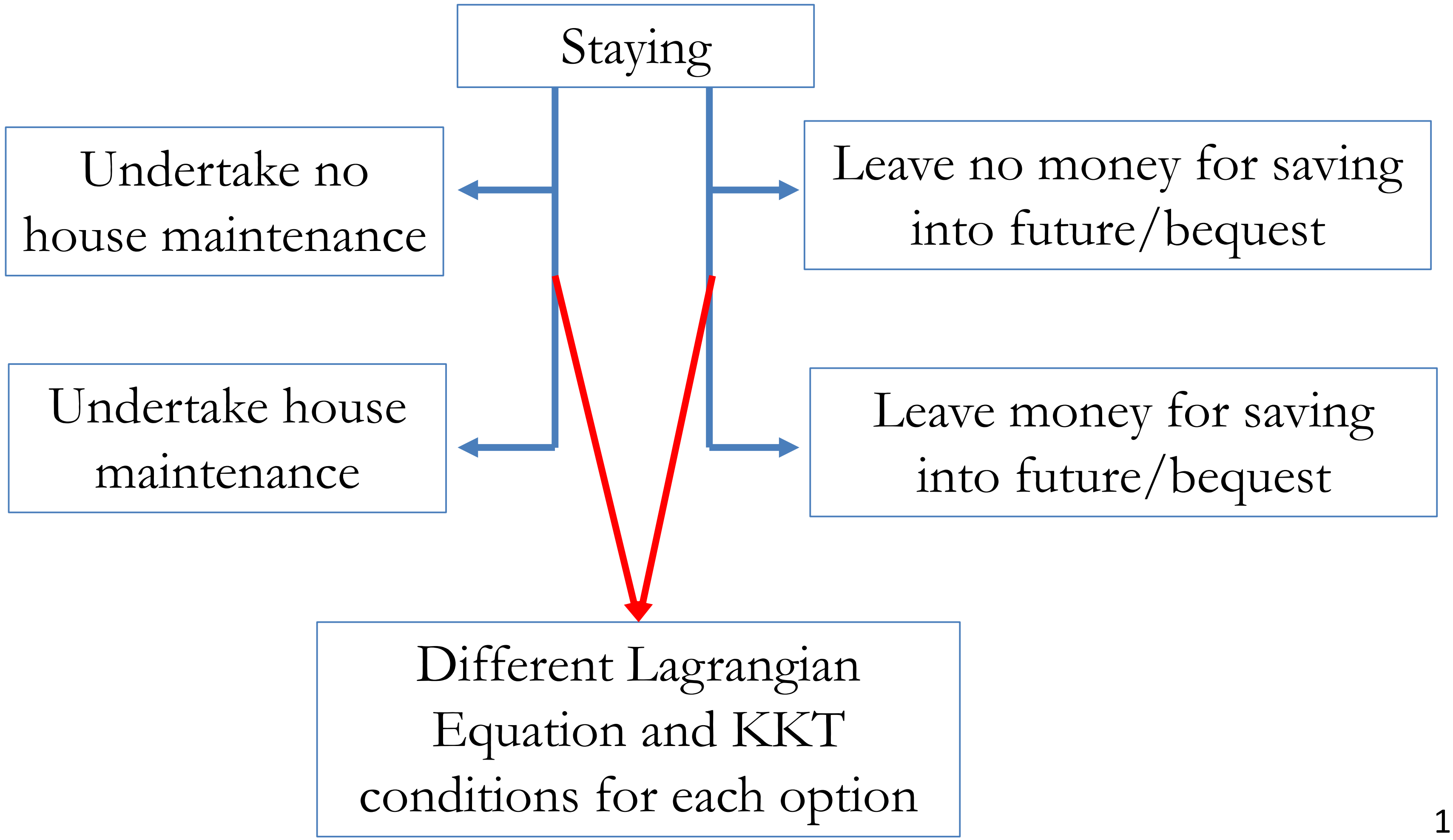
Rent Price, Current and Future House Prices are based on per sqm

$$interest = \left((1 + interest) * (1 + inflation) - 1\right) * (1 - tax)$$

Programming for Changing House



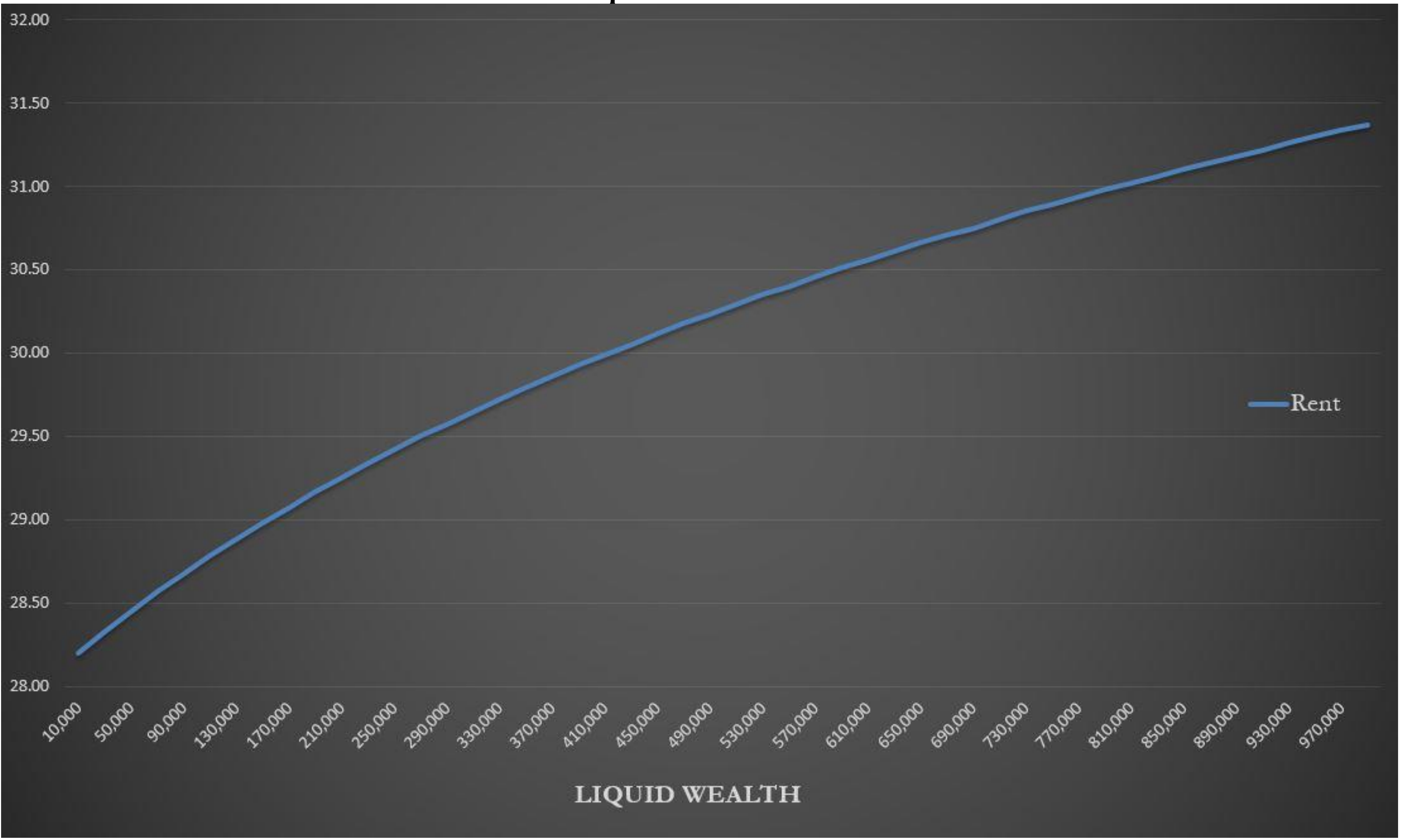
Programming for Remaining in House



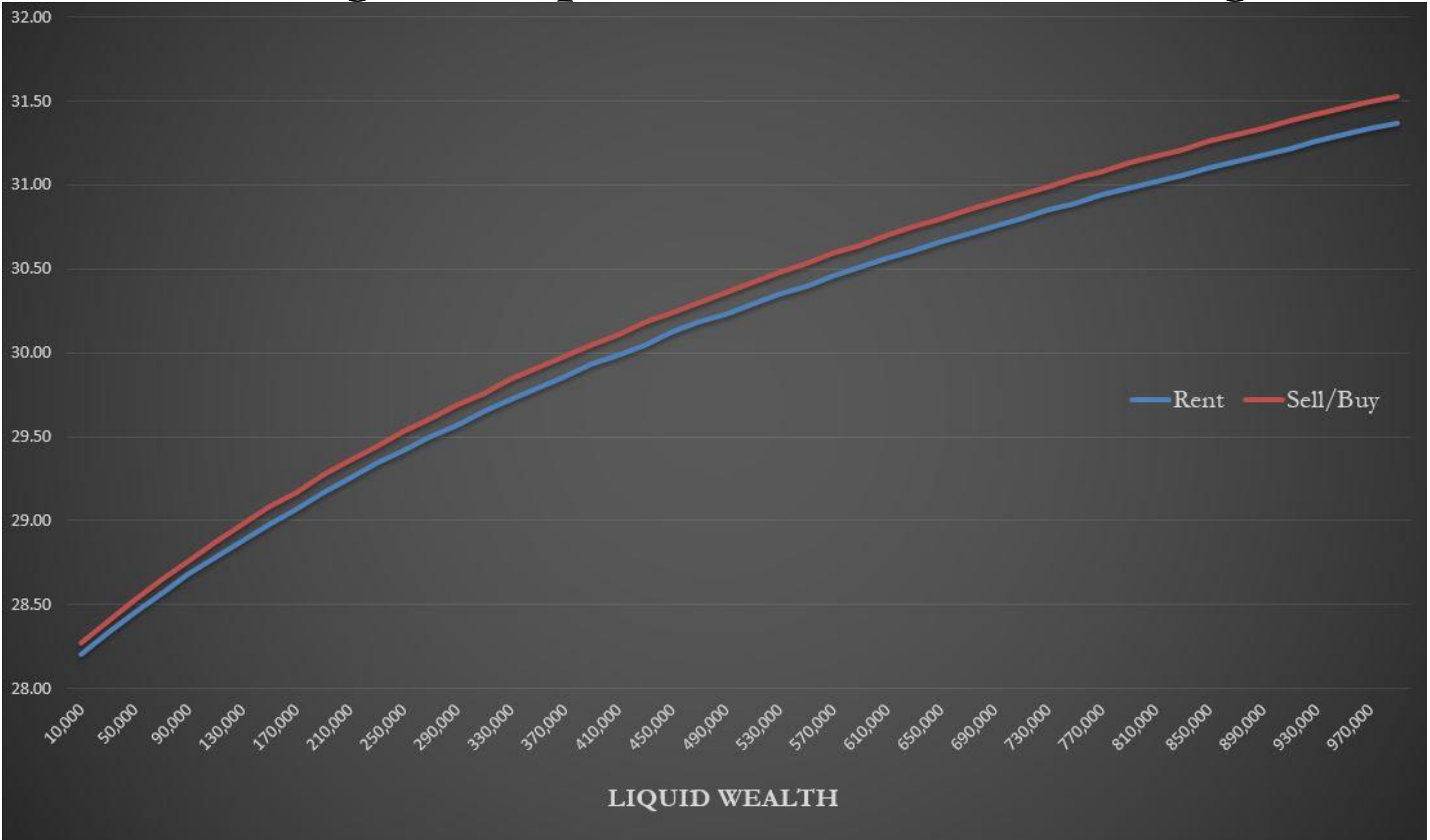
Simplified Parameterisation

- Assume Individuals have income \$0-\$25,000
- Asset level between \$0-\$1,000,000
- House size between 0-360sqm
- House price (psqm) of \$1,000-\$3,000
- 3 Health States (Good, Average, Bad)
- After the completing of the program, model will be fitted with actual New Zealand data to model real life situations

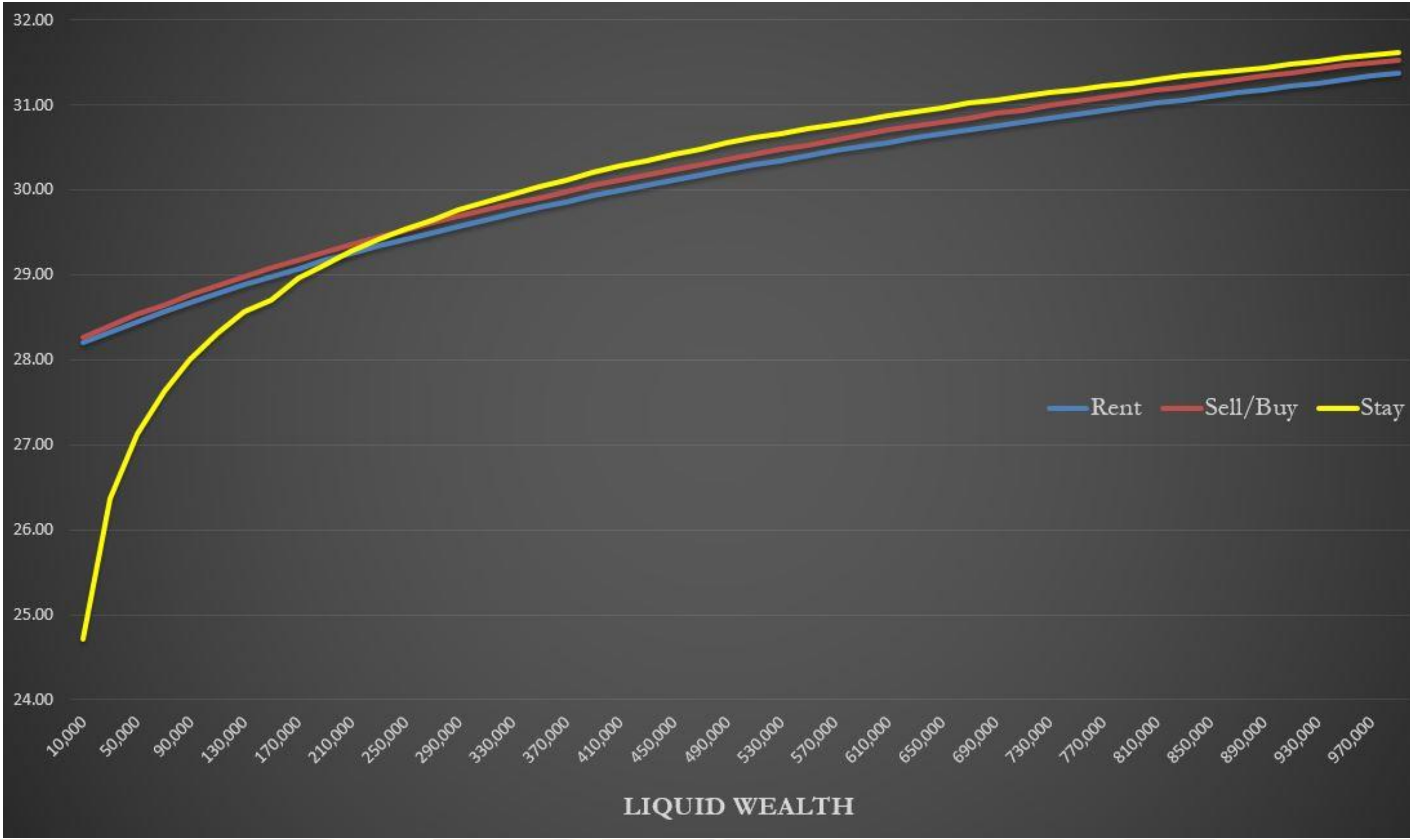
Utility with Good Health of Renting After Selling 200 sqm House



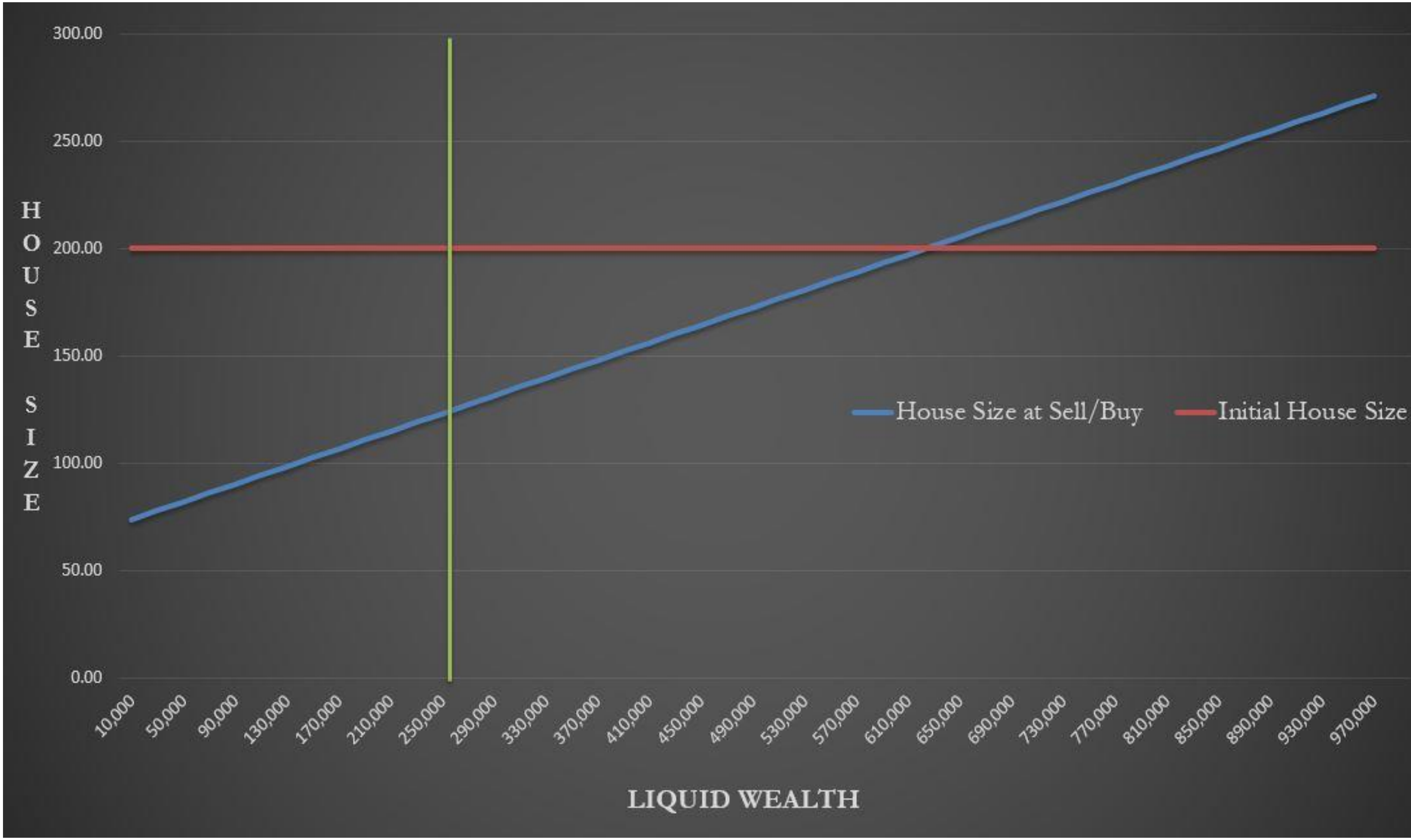
Utility with Good Health of New Home after Selling 200 sqm House versus Renting



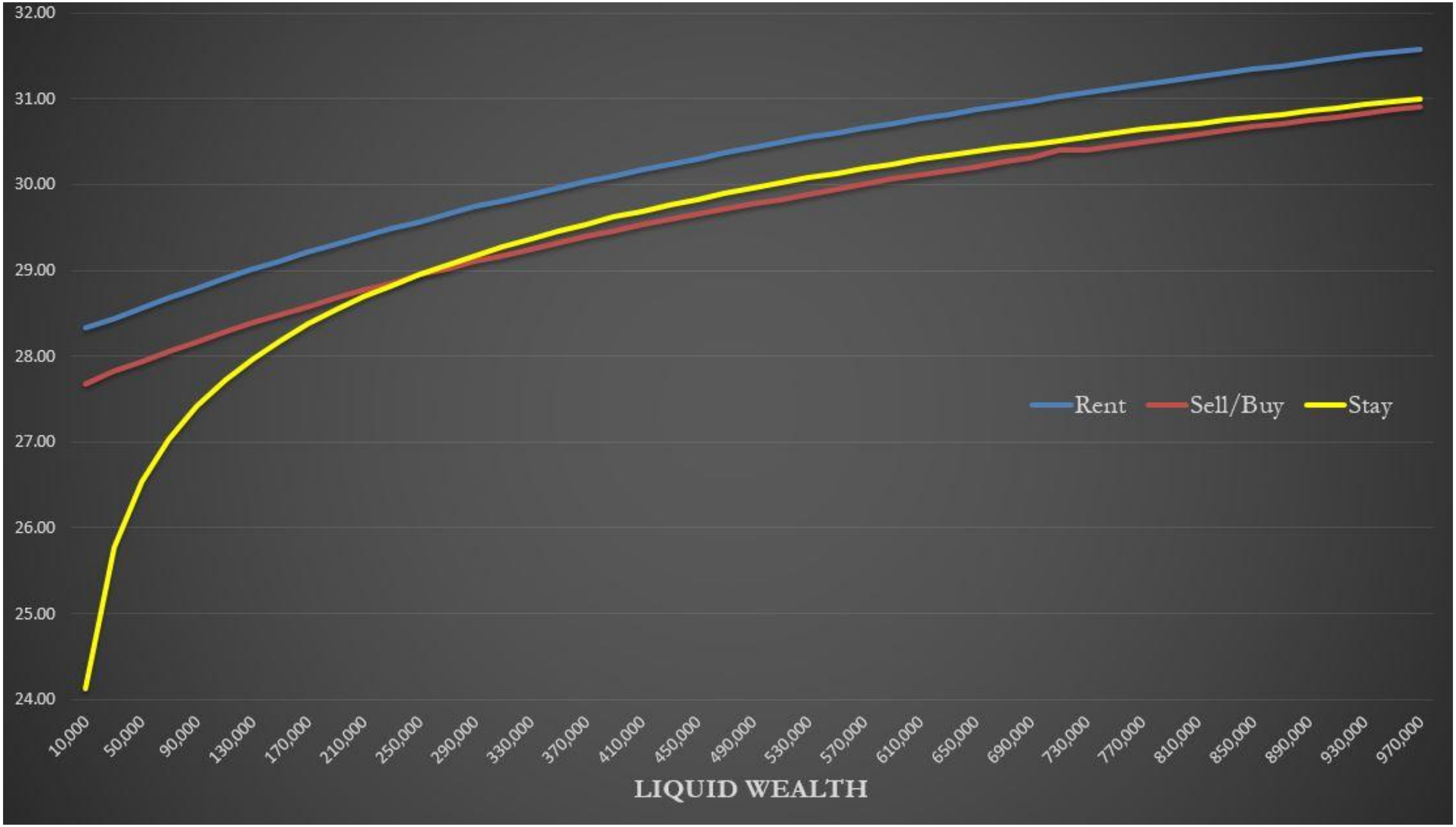
Utility with Good Health, All Housing Scenarios (Assuming Previous Home was 200 sqm)



Optimal House Size and Ownership



Utility of All Housing Scenario with Bad Health (200 sqm Initial House Size)



Conclusions (200 sqm House)

1. Under good health, downsizing is optimal for liquid asset holdings of less than NZD 270,000
2. Assuming good health, staying in current home is optimal for liquid asset holdings between above NZD 270,000
3. Bad health implies that renting maximises utility regardless of liquid asset holdings (supports Yogo, 2016 that bad health moves individuals away from housing asset)

Project Status

Introduction of Housing States Random income, health, house prices
Estimate Kuhn-Tucker conditions for all housing, saving and bequest options
Program Final period-solve for all three housing options and choose utility maximising option
Programming option 1 (rent) for all T-n periods
Programming option 2 and 3 for all T-n periods
Testing of program, parameterizing, simulations

THANK YOU

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Appendix

Lagrangian for Selling and Buying

$$u(chz) = \alpha_1 \ln(c) + \alpha_2 \ln(Hexp) + \alpha_3 \ln(size) + \beta \ln(10000 + Bequest)$$
$$-\lambda_1 [Be - (money - (c + HExp + size * Hp) + ExpP * size(1 - \delta) * Liq]$$
$$- \ \mu_1(c + HExp + size * Hp - money)$$

Lagrangian Staying in Current House

- $u(chz) = \alpha_1 \ln(c) + \alpha_2 \ln(Hexp) + \alpha_3 \ln(size) + \beta \ln(10000 + Bequest)$

$$-\lambda_1[Bequest - W + c + HExp + Hp * size * maintenance - (1 - \delta + maintenance) * size * P_{star}$$
$$+ \mu_1(W - c - HExp - Hp * size * maintenance)$$
$$+ \mu_2(maintenance)$$
$$+ \mu_3[Bequest - (1 - \delta)ExpP * size]$$

- $Bequest = (1 - \delta - maintenance)P_{star} * size$
- $W = c + HExp + Hp * size * maintenance$
- $P_{star} = ExpP * (1 - \delta) * Liq$

Calculations for Renting

a. They leave money bequest

- $c_{opt} = \alpha 1 * (10000 + money)/(\beta + \alpha 1 + \alpha 2 + \alpha 3)$
- $HExp_{opt} = \alpha 2 * (10000 + money)/(\beta + \alpha 1 + \alpha 2 + \alpha 3)$
- $Size_{opt} = (\alpha 3 * \frac{10000+money}{\beta+\alpha 1+\alpha 2+\alpha 3})/P_{rent}$
- $Bequest = money - c - HExp - size * P\_rent$

Calculations for Renting

b. They leave no bequest

- $c_{opt} = \alpha 1 * money/(\beta + \alpha 1 + \alpha 2)$
- $HExp_{opt} = \alpha 2 * money/(\beta + \alpha 1 + \alpha 2)$
- $Size_{opt} = (\alpha 3 * \frac{money}{\beta+\alpha 1+\alpha 2})/P\_rent$

Calculations for Selling and Buying

KKT conditions

- $\frac{\partial}{\partial c} \quad \frac{\alpha 1}{c} - \lambda_1 - \mu_1 = 0$
- $\frac{\partial}{\partial h} \quad \frac{\alpha 2}{HExp} - \lambda_1 - \mu_1 = 0$
- $\frac{\partial}{\partial s} \quad \frac{\alpha 3}{size} - \lambda_1 [Hp - P_{star}] - Hp * \mu_1 = 0$
- $\frac{\partial}{\partial B} \quad \frac{\beta}{10000 + Bequest} - \lambda_1 = 0$
- $P_{star} = ExpP(1 - \delta) * Liq$
- $\mu_1 = \frac{\alpha 3}{size * Hp} - \lambda_1 [Hp - P_{star}] / Hp$

Calculations for Selling and Buying

a. Leave money and house

- $c_{opt} = \alpha 1 * (10000 + money)/(\beta + \alpha 1 + \alpha 2 + \alpha 3)$
- $HExp_{opt} = \alpha 2 * (10000 + money)/(\beta + \alpha 1 + \alpha 2 + \alpha 3)$
- $Size_{opt} = \frac{\alpha 3 * (\frac{10000 + money}{\beta + \alpha 1 + \alpha 2 + \alpha 3})}{Hp - P\_star}$
- $Bequest = \left[\frac{\beta(money + 10000)}{\alpha 1 + \alpha 2 + \alpha 3}\right] - 10000$
- With the condition to be met:
- $money > c + HExp + size * Hp$
- $Hp > P\_star$

Calculations for Selling and Buying

b. Leave house only

- $c_{opt} = s_{opt} * Hp * \alpha 1/(\alpha 3 + \lambda_1 * P_{star} * s_{opt})$
- $HExp_{opt} = s_{opt} * Hp * \alpha 2/(\alpha 3 + \lambda_1 * P_{star} * s_{opt})$
- $Size_{opt} = size$
- $Bequest = size * P_{star}$
- With the conditions to be met:
- $\mu_1 > 0$
- $\mu_1 = \left(\frac{\alpha 3}{size} * Hp\right) - \lambda_1 \left(\frac{Hp - p_{star}}{p_{star}}\right) > 0$
- Holds automatically if $Hp - p_{star} \leq 0$

Calculations for Staying in Current House

KKT conditions

- $\frac{\partial}{\partial c} \quad \frac{\alpha 1}{c} - \lambda_1 - \mu_1 = 0$
- $\frac{\partial}{\partial h} \quad \frac{\alpha 2}{HExp} - \lambda_1 - \mu_1 = 0$
- $\frac{\partial}{\partial m} \quad [\lambda_1(P_{star} - Hp) * size] - \mu_1 * Hp * size + \mu_2 = 0$
- $\frac{\partial}{\partial Be} \quad \frac{\beta}{1000+Bequest} - \lambda_1 + \mu_3 = 0$

Calculations for Staying in Current House

a. Leave neither maintenance nor money

- $c_{opt} = \alpha 1 * W/(\alpha 1 + \alpha 2)$
- $HExp_{opt} = \alpha 2 * W/(\alpha 1 + \alpha 2)$
- $Size_{opt} = size$
- $maintenance = 0$
- $Bequest = (1 - \delta) * ExpP * size$
- With the condition(s) to be met:
- $\frac{\alpha 1}{c} > \frac{\beta}{10000+(1-\delta)*ExpP*size}$

Calculations for Staying in Current House

b. Leave only money

- $c_{opt} = \alpha 1[W + (1-\delta) * ExpP * size + 10000]/(\alpha 1 + \alpha 2 + \beta)$
- $HExp_{opt} = \alpha 2[W + (1-\delta) * ExpP * size + 10000]/(\alpha 1 + \alpha 2 + \beta)$
- $Size_{opt} = size$
- $maintenance = 0$
- $Bequest = \left(\frac{\beta[W+(1-\delta)*ExpP*size+10000]}{\alpha 1+\alpha 2+\beta}\right) - 10000$
- With the condition(s) to be met:
- $Exp - Hp < 0 \; or \; Exp < P$ (in the event of falling future house price, there is no incentive to undertake maintenance)

Calculations for Staying in Current House

c. Leave only maintenance

- $c_{opt} = \alpha 1[(W + (1-\delta) * HP * size) + (10000 * \frac{Hp}{ExpP})]/(\alpha 1 + \alpha 2 + \beta)$
- $HExp_{opt} = \alpha 2[(W + (1-\delta) * HP * size) + (10000 * \frac{Hp}{ExpP})]/(\alpha 1 + \alpha 2 + \beta)$
- $Size_{opt} = size$
- $maintenance = (W - c_{opt} - HExp_{opt})/(Hp * size)$
- $Bequest = \left(\beta * \frac{ExpP}{Hp}\right) * (W + (1-\delta) * HP * size) + (10000 * \frac{Hp}{ExpP})$
- With the condition(s) to be met:
- $ExpP > P$ (in the event of increasing house price, there is incentive to undertake maintenance)

Calculations for Staying in Current House

d. Leave maintenance and money

- $c_{opt} = \alpha1[(W + 10000 + (1 - \delta) * HP * size)/(\alpha1 + \alpha2 + \beta)$
- $HExp_{opt} = \alpha2[(W + 10000 + (1 - \delta) * HP * size)/(\alpha1 + \alpha2 + \beta)$
- $Size_{opt} = size$
- $maintenance = 0$
- $Bequest = \left(\frac{\beta[W+(1-\delta)*HP*size+10000]}{\alpha1+\alpha2+\beta}\right) - 10000$
- With the condition(s) to be met:
- $ExpP = P$ (in the event of stagnant house price, we are indifferent to whether leaving money or maintenance so let's assume maintenance is 0 and all leaving money)