Why Money Trickles Up
Bullet Points

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0.2 Introduction

- highlights of full paper 'Why Money Trickles Up'
- introduces mathematical and simulation models that use basic economic variables
- give straightforward explanations of the distributions of wealth, income and company sizes
- explains the source of macroeconomic business cycles, including bubble and crash behaviour.
- models give simple formulae for the Bowley ratio; the ratio of returns to labour and capital.
- provide simple effective methods for eliminating poverty without using tax and welfare.

- Ian Wright, Makoto Nirei & Wataru Souma have produced work on similar lines

- the general approach for the macroeconomic models were partly inspired by the work of Steve Keen

- indebted to the work of Levy & Solomon and their GLV models.

1. Wealth & Income Models

1.1 Wealth & Income Data – Empirical Information

- Power 'Pareto' tail
- 'log-normal' body
- persistent patterns across societies with different economic systems

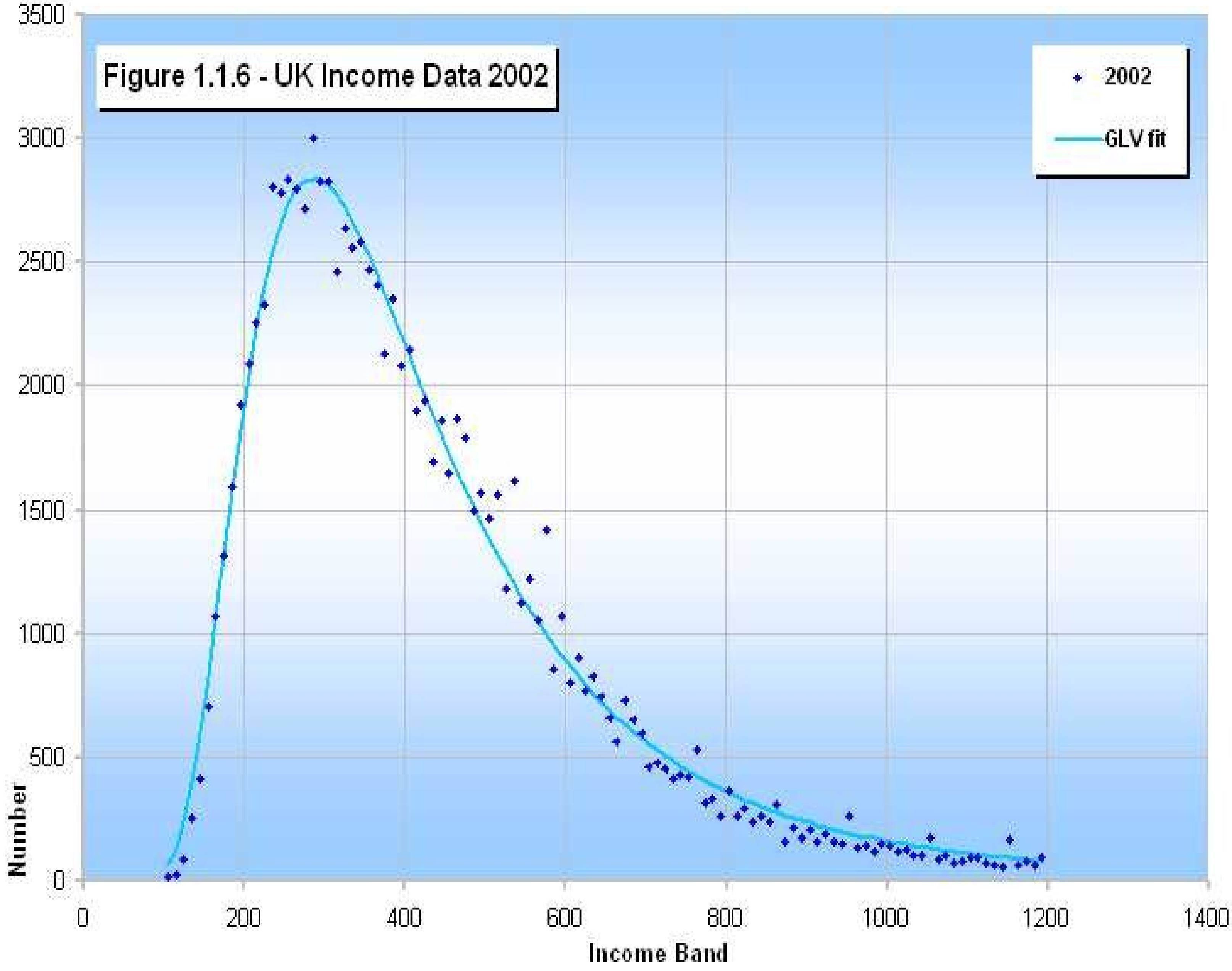


Figure 1.1.6 - UK Income Data 2002
2002
GLV fit
3500
3000
2500
2000
1500
1000
500
0
Number
0
200
400
600
800
1000
1200
1400
Income Band

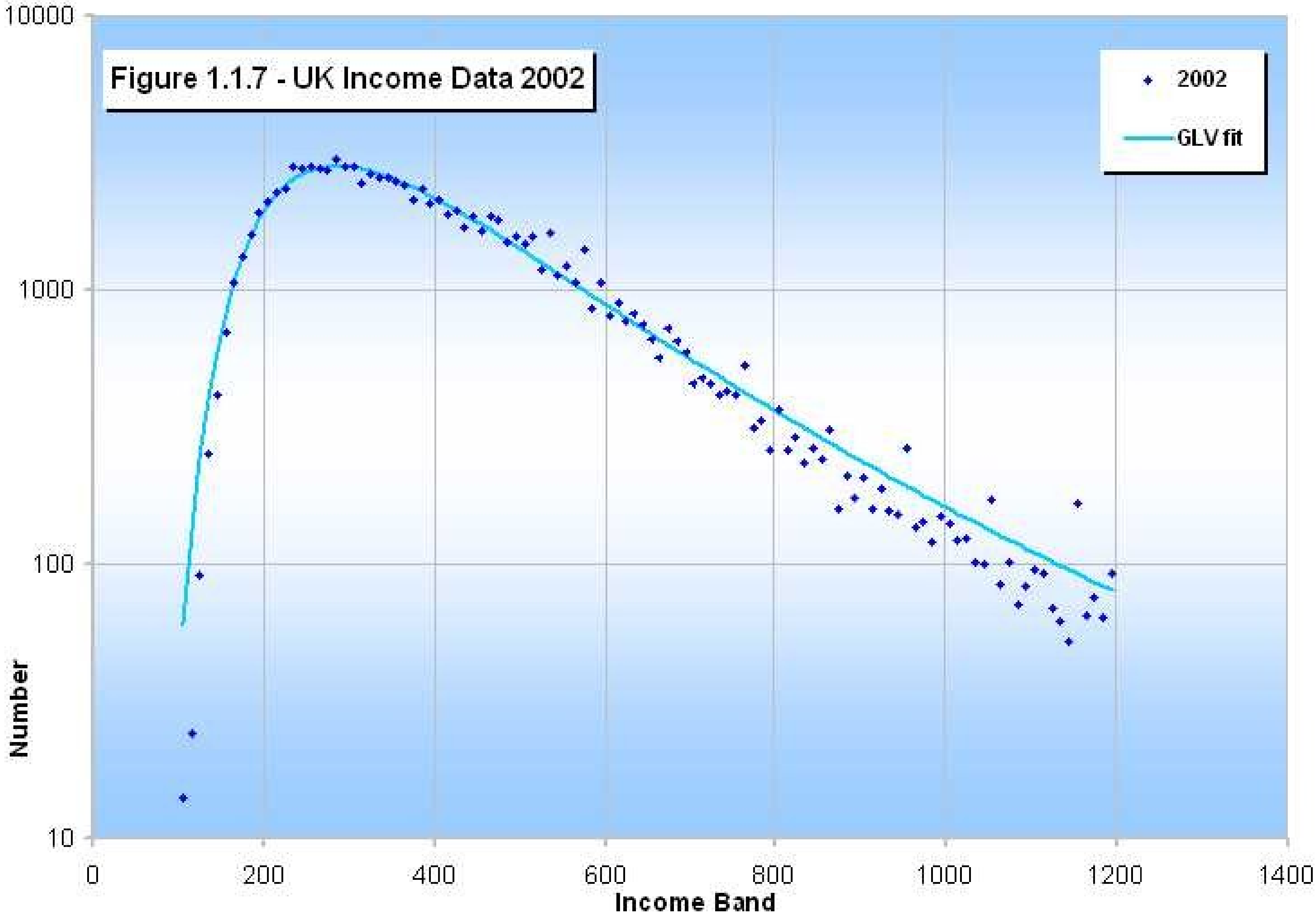


Figure 1.1.7 - UK Income Data 2002
2002
GLV fit
Number
Income Band
10000
1000
100
10
0
200
400
600
800
1000
1200
1400

General Lotka-Volterra - (GLV)

- can fit power tail
- can fit log-normal body
- has offset from zero
- gives very good fit to data

Figure 1.1.8	Reduced Chi Squared	
	Full Data Set	Reduced Data Set (no power tail)
Boltzmann Fit	3.27	1.94
Log Normal Fit	2.12	3.02
GLV Fit	1.21	1.83

- can be modelled with sensible economic model

1.2.1 Lotka-Volterra systems

- population of prey x (say rabbits)
- population of predators y (say foxes)
- no predators present, natural population growth rate 'a' of rabbits:

$$\frac{dx}{dt} \propto ax \qquad (1.2.1a)$$

- no rabbits to eat, natural death rate 'c' of the foxes:

$$\frac{dy}{dt} \propto -cy \qquad (1.2.1b)$$

- foxes encounter rabbits, rate at which rabbits are killed is proportional to the number of rabbits and the number of foxes:

$$\frac{dx}{dt} \propto -\alpha x y \qquad (1.2.1c)$$

- α is a constant, and the –ve sign, not good for the rabbits.
- However good for the foxes, giving:

$$\frac{dy}{dt} \propto \gamma x y \qquad (1.2.1d)$$

- γ is fixed constant.

- gives a pair of differential equations:

$$\frac{dx}{dt} = ax - \alpha x y$$

$$= x(a - \alpha y) \qquad (1.2.1e)$$

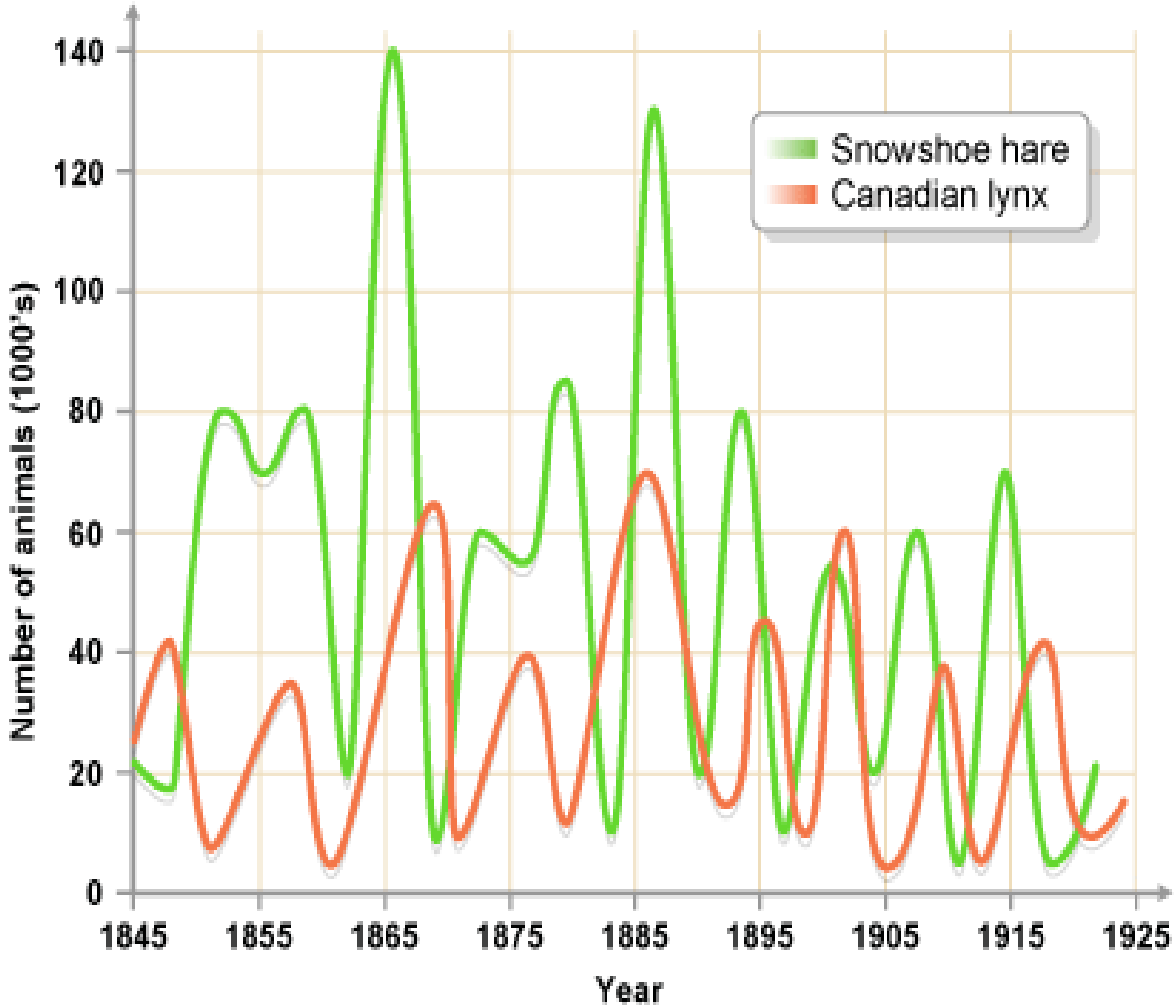
for the rabbits; while for the foxes:

$$\frac{dy}{dt} = \gamma x y - cy$$

$$= y(\gamma x - c)$$

$$= y(-c + \gamma x) \qquad (1.2.1f)$$

• Normally unstable system:



1.2.2 General Lotka-Volterra (GLV) systems

- General Lotka-Volterra system (GLV) extends Lotka-Volterra model to multiple predators and prey:

$$\frac{dx_i}{dt} = x_i r_i + \sum_{j=1}^{N} a_{i,j} x_i x_j \qquad (1.2.2a)$$

$$= x_i \left(r_i + \sum_{j=1}^{N} a_{i,j} x_j \right) \qquad (1.2.2b)$$

- dx_i/dt is rate of change for the i-th species, out of a total of N species.

- first term natural growth (or death) rate, r_i, for the species with population x_i. Rate r_i is equivalent to the growth rate 'a' in equation (1.2.1e) or the death rate '-c' in equation (1.2.1f).
- second term gives the sum of all the interactions with the j number of other species. $a_{i,j}$ is the interaction rate defining the relationship between species i and j.
- $a_{i,j}$ is negative if species j is a predator, positive if species i is a predator. $a_{i,j}$ is equivalent to the α of equation (1.2.1e) or the γ of equation (1.2.1f).
- Equations (1.2.2a) and (1.2.2b) are generalisations of equations (1.2.1e) and (1.2.1f) for many interacting species.

- potentially N! separate differential equations are needed to describe the whole system.

- Simplified by Solomon & Levy [Solomon 2000]
- difference equation for city population sizes.

$$w_{i,t+1} = w_{i,t} + rw_{i,t} + a_t \bar{w}_t - c_t \bar{w}_t w_{i,t}$$

$$w_{i,t+1} = \lambda w_{i,t} + a_t \bar{w}_t - c_t \bar{w}_t w_{i,t} \qquad (1.2.2c)$$

- uses w bar as average population
- λ is the natural growth rate of the population w of city i,
- a_t is the arrival rate of population from other cities, multiplied by the average population $\bar{w}$ of all the cities.
- c_t gives the rate of population leaving each city

- λ, a and c are universal rates, applicable to all members of the system.
- λ and a ‘positive autocatalytic’ (positive feedback), increase the population w of each city.
- negative value of c decreases the population of each city.
- Without the negative feedback term, the populations of the cities can increase to infinity
- Without the positive autocatalytic growth of λ in the first term, the second and third terms will cause all of the population to end up in a single city.
- Normally one or more variables are assumed to be stochastic.

- Gives a stable probability distribution for city populations:

$$P(w) \propto (e^{-(\alpha-1)/w})/(w^{(1+\alpha)}) \qquad (1.2.2d)$$

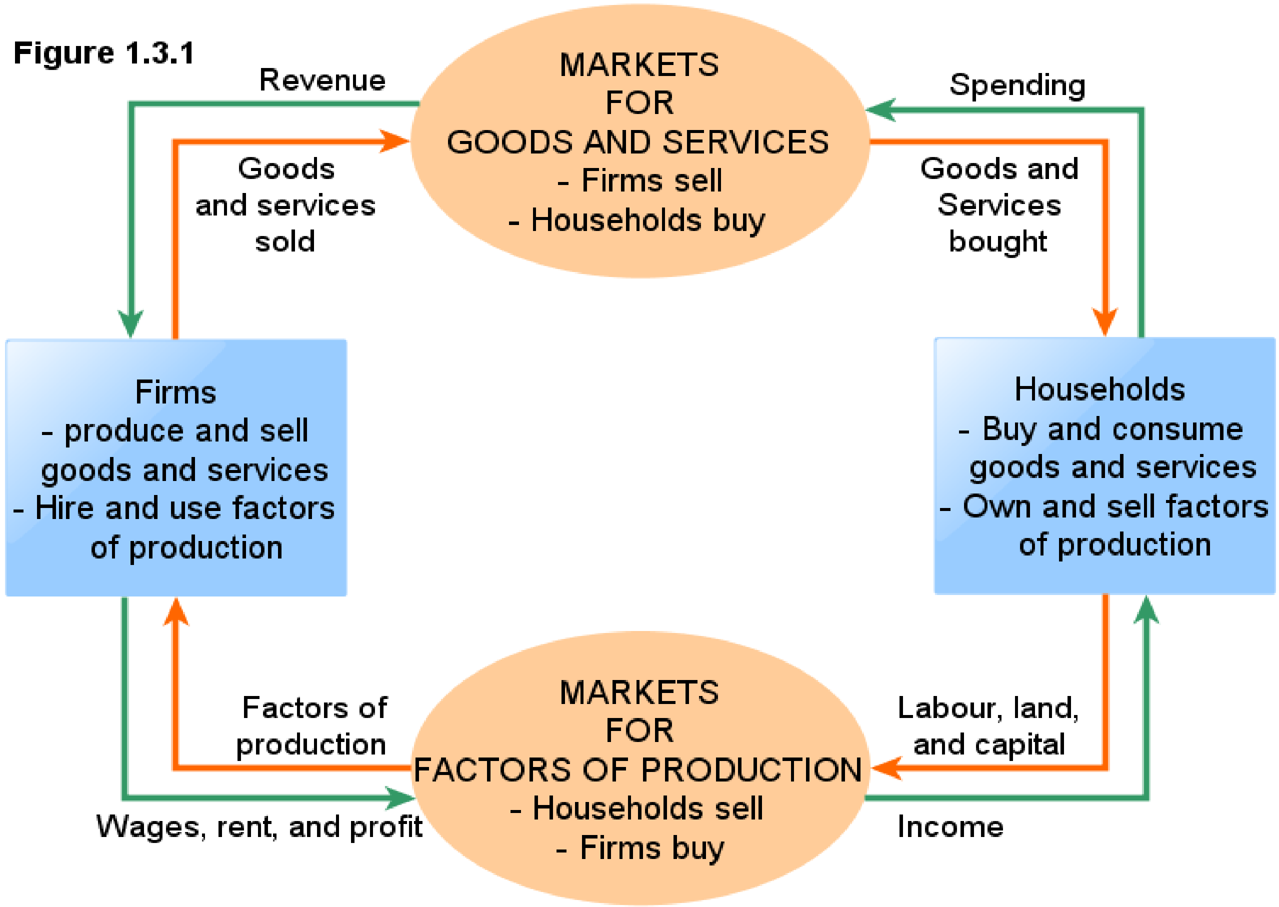
$$P(w) = K(e^{-(\alpha-1)/(w/L)})/((w/L)^{(1+\alpha)}) \qquad (1.2.2e)$$

- Lotka-Volterra – feedback from x to y,

  and also feedback from y to x.
- GLV – feedback from x_i to all the other $x_{j.}$

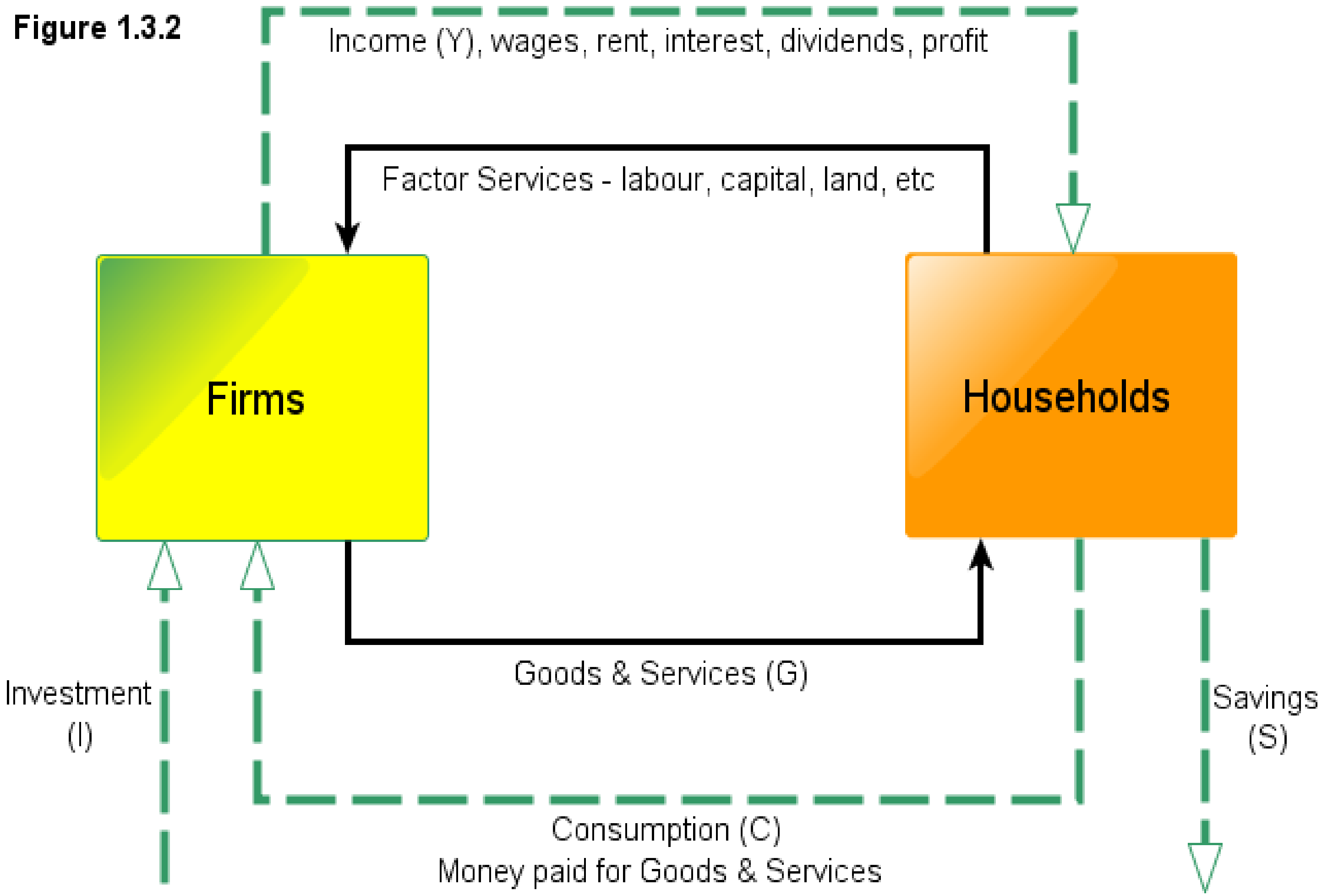
1.3 Wealth & Income Models - Modelling

- traditional economic model:



• Typical 'circular flow'

Figure 1.3.2



- Incorrect – shows flow of capital and land from households to firms

- Householders don't sell blast furnaces to companies

- Investment & saving not main source of capital

- *"Most corporations, in fact, do not finance their investment expenditure by borrowing from banks."* [Miles & Scott 2002, 14.2]

TABLE 14.1 The Financing of Investment: Flow-of-funds Estimated (%) (1970–1994)

	Germany	Japan	UK	USA
Internal finance	78.4	69.9	95.6	94.0
Bank finance	12.0	30.1	15.0	12.8
Bond finance	−1.0	3.4	3.8	15.3
New equity	−0.02	3.4	−5.3	−6.1
Other	10.6	−6.8	−9.1	−16.0

Note: Internal finance comprises retained earnings and depreciation. The other category includes trade credit and capital transfers. The figures represent weighted averages where the weights for each country are the level of real fixed investment in each year in that country.

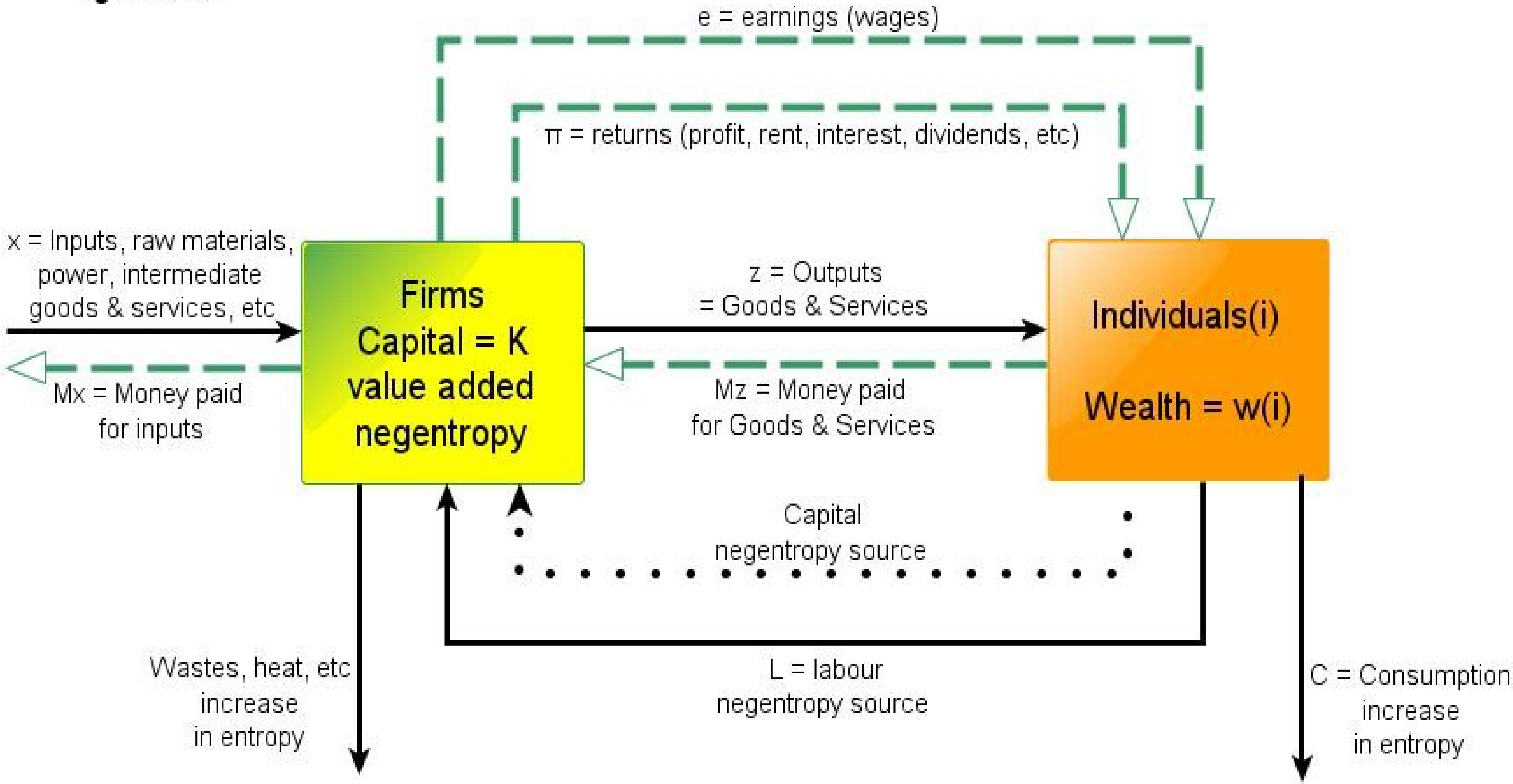
Source: Corbett and Jenkinson, "How Is Investment Financed?" *The Manchester School* (1996) vol. LXV, pp. 69–94.

- Models in this paper assume capital is invested using internal finance

- Investment and saving ignored as secondary loop
    - returned to at end of paper

- Gives base model:

Figure 1.3.5



e = earnings (wages)
π = returns (profit, rent, interest, dividends, etc)
x = Inputs, raw materials, power, intermediate goods & services, etc
Firms
Capital = K
value added
negentropy
z = Outputs
= Goods & Services
Individuals(i)
Wealth = w(i)
Mx = Money paid for inputs
Mz = Money paid for Goods & Services
Capital negentropy source
Wastes, heat, etc increase in entropy
L = labour negentropy source
C = Consumption increase in entropy

- K – 'real' capital; machines, land, buildings, etc
- W – 'financial' capital; shares, bonds, loans, etc
- black lines flows of real goods
- green lines flows of money / financial instruments
- dotted line indicates ownership of K by W
- dotted line is not a flow
- Consumption shown as real flow
- Mz – economist's consumption
- Returns Y split into earnings e and returns π

- in wealth & income models, assume total wealth is constant:

$$\text{total}\,W \;=\; \text{total}\,K \qquad (1.3c) \qquad \text{or:}$$

$$\sum w_i \;=\; W \;=\; K \;=\; \text{constant} \qquad (1.3d)$$

Simple Model:

- economy is isolated; no imports or exports.
- no government sector, no taxation, welfare payments, government spending, etc.
- no unemployment; all individuals are employed
- Labour and capital are complementary inputs and are not interchangeable.
- The role of money is ignored.
- no debt

Classical Economics & Entropic model

- Value is meaningful intrinsic property
- value is created in production
- value is destroyed in consumption
- flow model – not exchange model

- value is normally conserved in exchange – neither party in exchange benefits

- value is ‘negentropy’ or ‘humanly useful free energy’
- 'negentropy theory of value'
- waste streams included so that the 2nd law of thermodynamics is not violated.

- at steady state equilibrium.

$$\text{total } C = \text{total } Y = \text{total } Mz$$

- but C and Y may be different for individuals

$$\sum w_{i,t} = \sum w_{i,t+1} = W = K = \text{constant} \qquad (1.3\,e)$$

- For single individual:

$$w_{i,t+1} = w_{i,t} + y_{i,t} - Mz_{i,t} + e_{i,t} + \pi_{i,t} - C_{i,t} - labour_{i,t} - capital_{i,t} \qquad (1.3f)$$

- $y_{i,t}$, $C_{i,t}$, labour and capital are real units, others are financial.

- Looking only at the financial flows:

$$w_{i,t+1} = w_{i,t} - Mz_{i,t} + e_{i,t} + \pi_{i,t} \qquad (1.3g)$$

- Use $C_{i,t}$ in place of – $Mz_{i,t}$. $C_{i,t}$ is now a monetary unit; reverts to standard economics usage gives:

$$w_{i,t+1} = w_{i,t} + e_{i,t} + \pi_{i,t} - C_{i,t} \qquad (1.3h)$$

- In a single iteration, the paper wealth w of an individual i
  - increases by the wages earned e
  - increases by the profits received π.
  - reduces by the amount spent on consumption C.

- e – is either uniform distribution or normal distribution, defined in model - exogenous

- profit is proportional to wealth, given by market profit rate r:

$$\pi_{i,t} = w_{i,t} r \qquad (1.3j) \qquad \text{for each of the i agents.}$$

- Consumption also proportional to wealth, given by consumption rate Ω :

$$C_{i,t} = w_{i,t} \Omega \qquad (1.3n)$$

Substitute into (1.3h) gives the difference equation for each agent:

$$w_{i,t+1} = w_{i,t} + e_{i,t} + w_{i,t}r - w_{i,t}\Omega \qquad (1.3o)$$

- Equation (1.3o) is base equation for a single agent in all income models.

- w is the only variable.

- e, r and Ω are all constants; though can be stochastic around long-term constant value

- In income models:

$$Y = \sum e_i + \sum \pi_i = \text{constant}, \quad \text{always} \qquad (1.3p) \quad \text{and}$$

$$\sum e_i = \sum \pi_i = \frac{Y}{2} \qquad \text{usually} \qquad (1.3q)$$

- Accords with 'Bowley's Law' returns to labour typically between 0.75 and 0.5 of total returns.

Some definitions:

$$\text{Profit rate} \qquad r = \frac{\sum \pi}{\sum w} \tag{1.3r}$$

$$\text{Income rate} \qquad \Gamma = \frac{\sum Y}{\sum w} \tag{1.3s}$$

$$\text{Bowley ratio} \qquad \beta = \frac{\sum e}{\sum Y} \qquad (1.3t)$$

$$\text{Profit ratio} \qquad \rho = \frac{\sum \pi}{\sum Y} \qquad (1.3u)$$

- by definition:

$$\beta + \rho = 1 \qquad (1.3v)$$

$$\text{Profit ratio} \qquad \rho = \frac{r}{\Gamma} \qquad (1.3w)$$

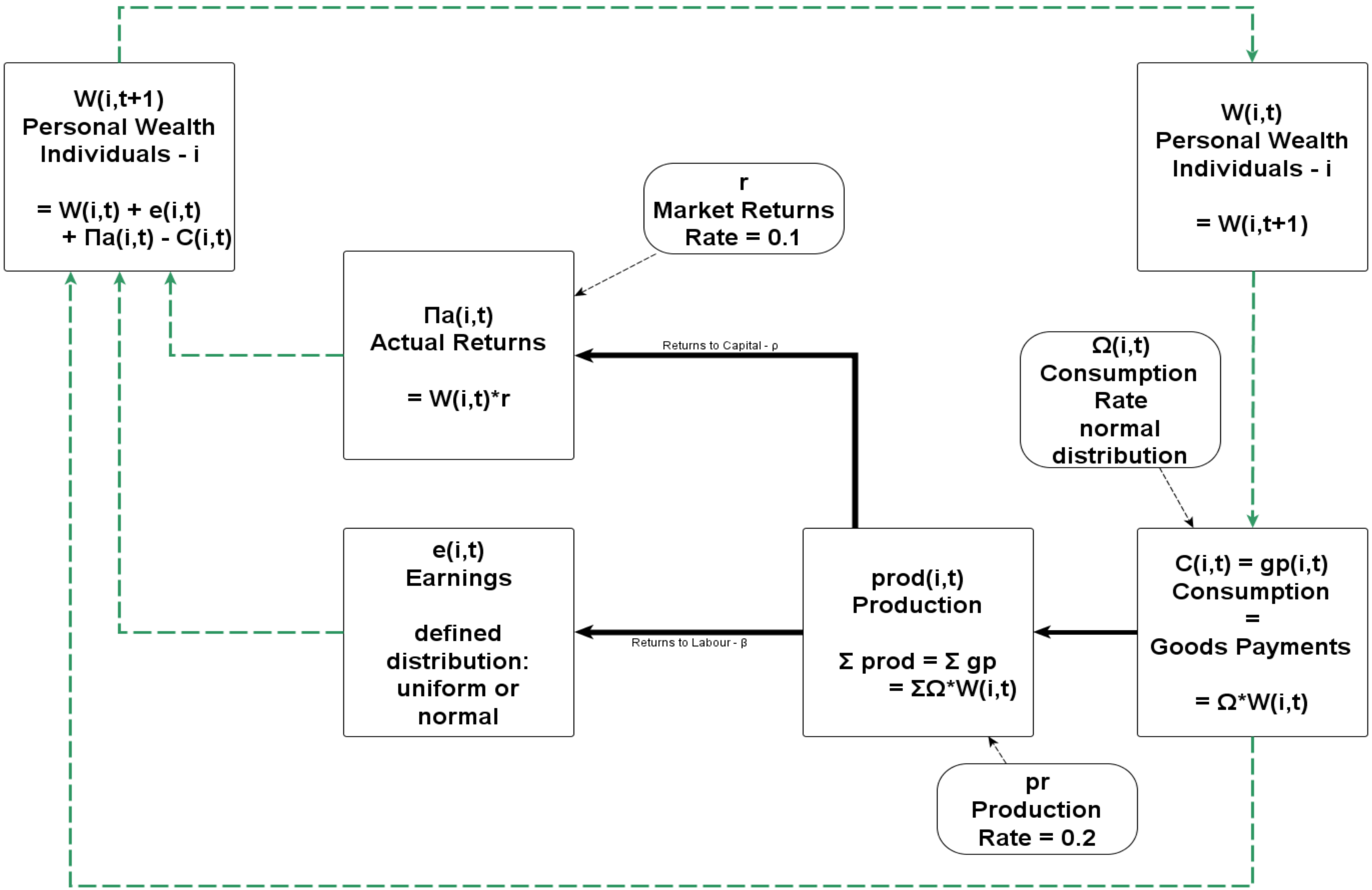
important subtlety:

- textbook economics; C = Y by definition
- in these models consumption becomes equal to income automatically by adjusting wealth
- final consumption term gives automatic feedback

Formula for iterations:

$$w_{i,t+1} = w_{i,t} + e_{i,t} + w_{i,t} r - w_{i,t} \Omega \qquad (1.3o)$$

Figure 1.3.9
Wealth & Income Model
Iteration Diagram



1.4 Wealth & Income Modelling - Results

1.4.1 Model 1A Identical Waged Income, Stochastic on Consumption

- Earnings – uniform distribution
- all agents have identical productive ability

- consumption stochastic from normal distribution
- consumption constant and identical over long run

- **All agents absolutely identical**
- perfect fit to GLV for wealth (as expected)
- also gives power tail:

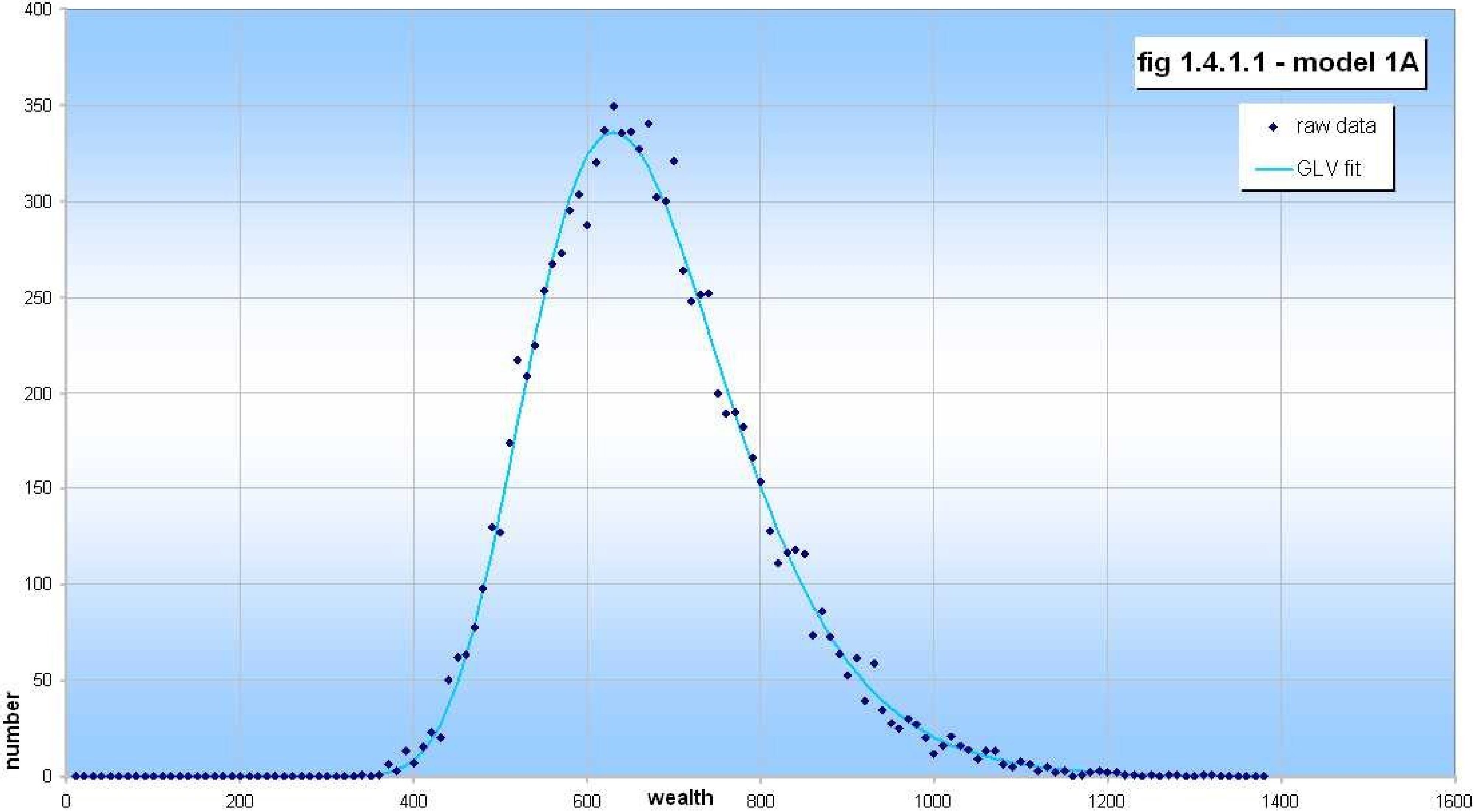


fig 1.4.1.1 - model 1A
raw data
GLV fit
number
wealth
0
50
100
150
200
250
300
350
400
0
200
400
600
800
1000
1200
1400
1600

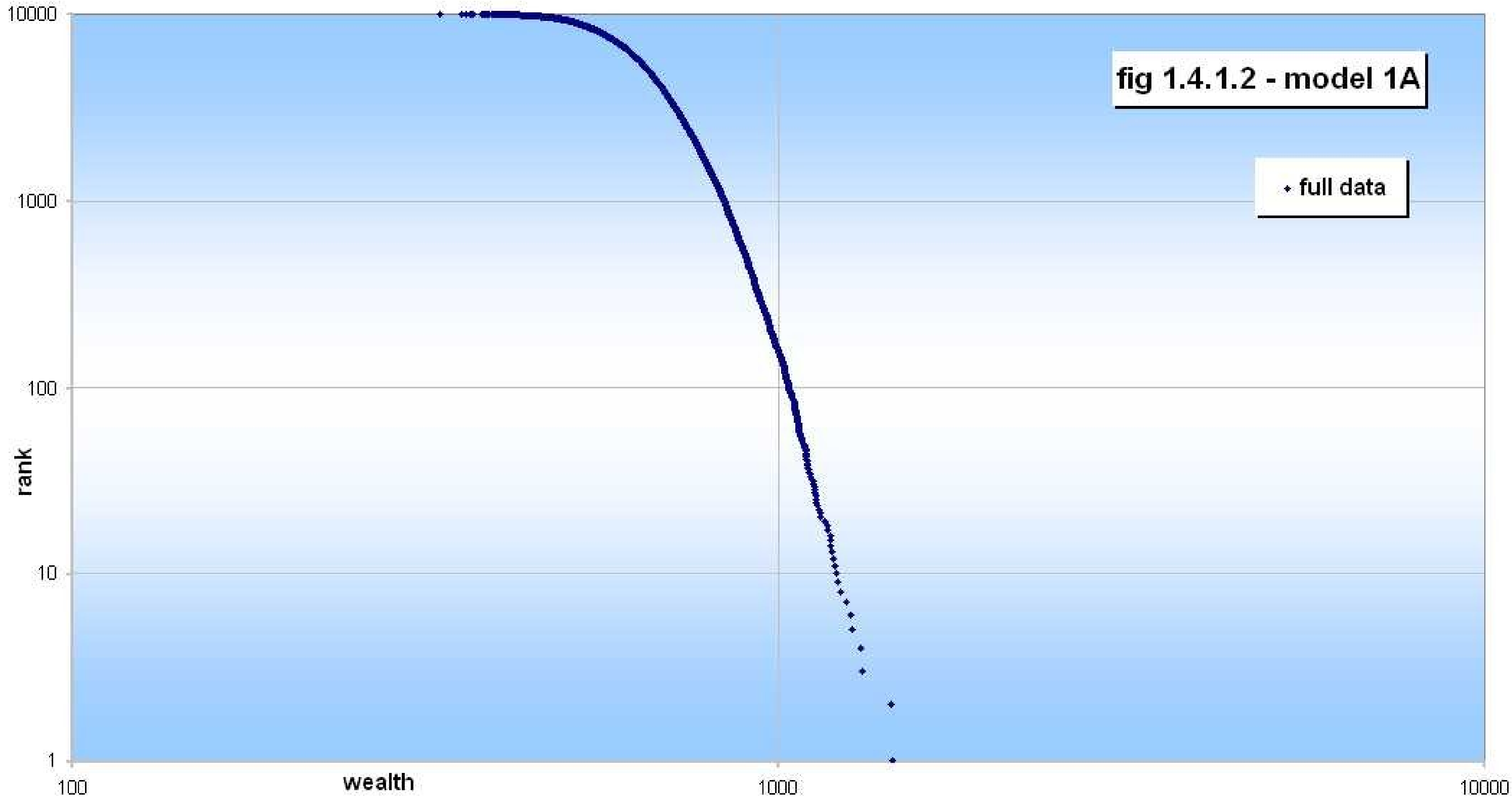


fig 1.4.1.2 - model 1A
full data
rank
wealth
10000
1000
100
10
1
100
1000
10000

- **highly unequal wealth distribution produced from identical agents**

- Wealth distribution is a simple result of statistical mechanics; of entropy.

- The fundamental driver forming this distribution of wealth is not related to ability or utility in any way whatsoever.

- Income not analysed as agents move up and down in the distribution very rapidly

1.4.2 Model 1B Distribution on Waged Income, Identical Consumption, Non-stochastic

- Earnings – normal distribution at start of run (not stochastic)
- Consumption – uniform distribution
- dull model – output distribution is identical to input distribution
- **distribution of consumption / savings rates is key to wealth condensation effects**

1.4.4 Model 1D Distribution on Consumption and Waged Income, Non-stochastic

- Earnings – normal distribution at start of run (not stochastic)
- Consumption – normal distribution at start of run (not stochastic)
- Produces GLV for wealth distribution
- Produces apparent GLV distribution for income

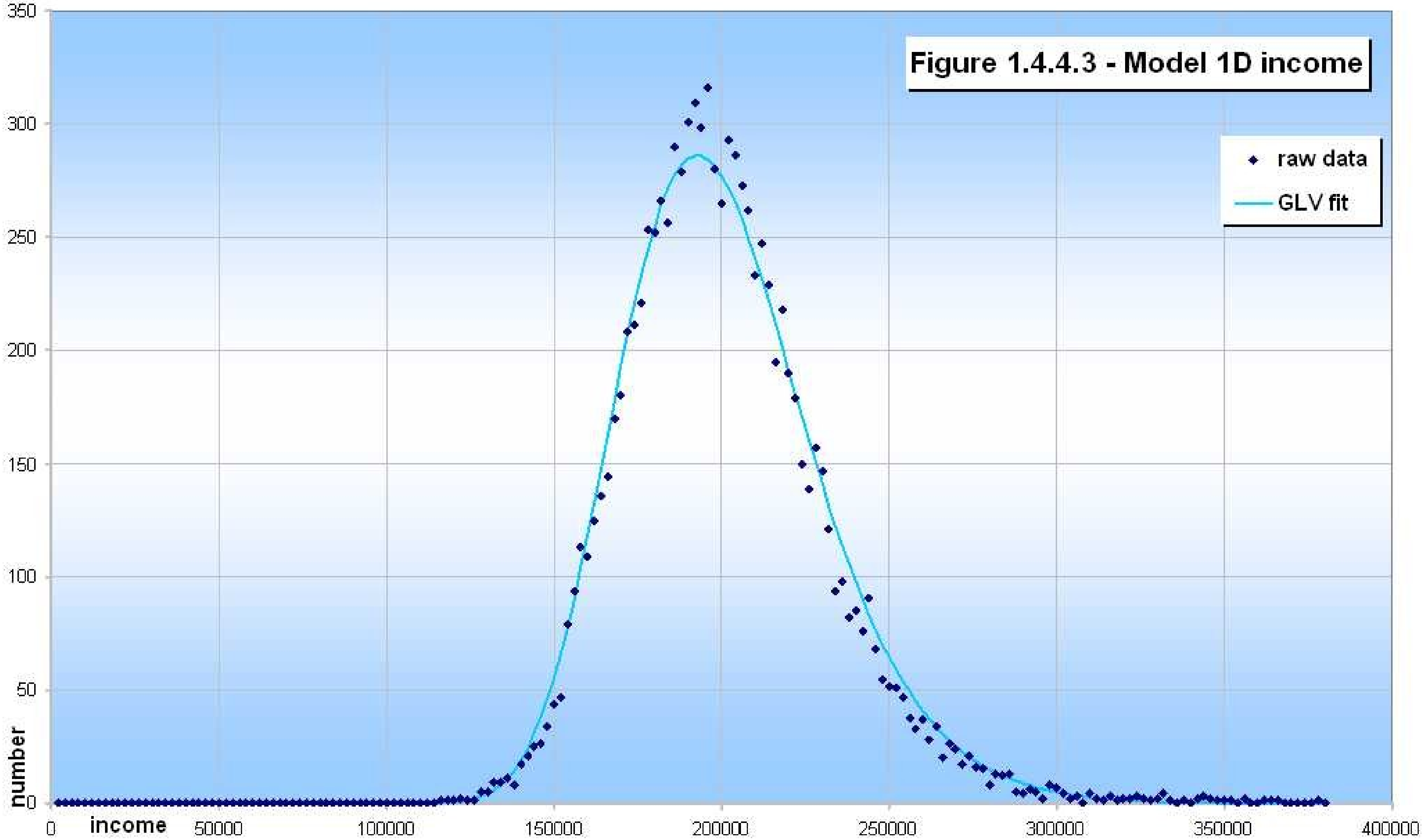


Figure 1.4.4.3 - Model 1D income
raw data
GLV fit
number
income
0
50
100
150
200
250
300
350
0
50000
100000
150000
200000
250000
300000
350000
400000

- actually a combination of two underlying distributions:
  - GLV distribution of income from wealth – which is proportional to wealth (via r)
  - and normal distribution of earnings income – defined in model
- result looks like GLV

1.5 Wealth & Income Modelling - Discussion

- Output distributions for wealth and income are much more unequal than input earnings / consumption distributions.

- Wealth condensation model – caused by statistical mechanics

- System involving capital changes normal distributions into power tail distributions

- natural split between wealth owning class and working/middle class dependent on earnings

- rather than 'predator-prey' model better to think as grazing model – sheep graze grass, humans 'graze' wool from sheep.

- ownership of capital allows 'grazing'

- Rupert Murdoch grazes on many people due to ownership of many newspapers

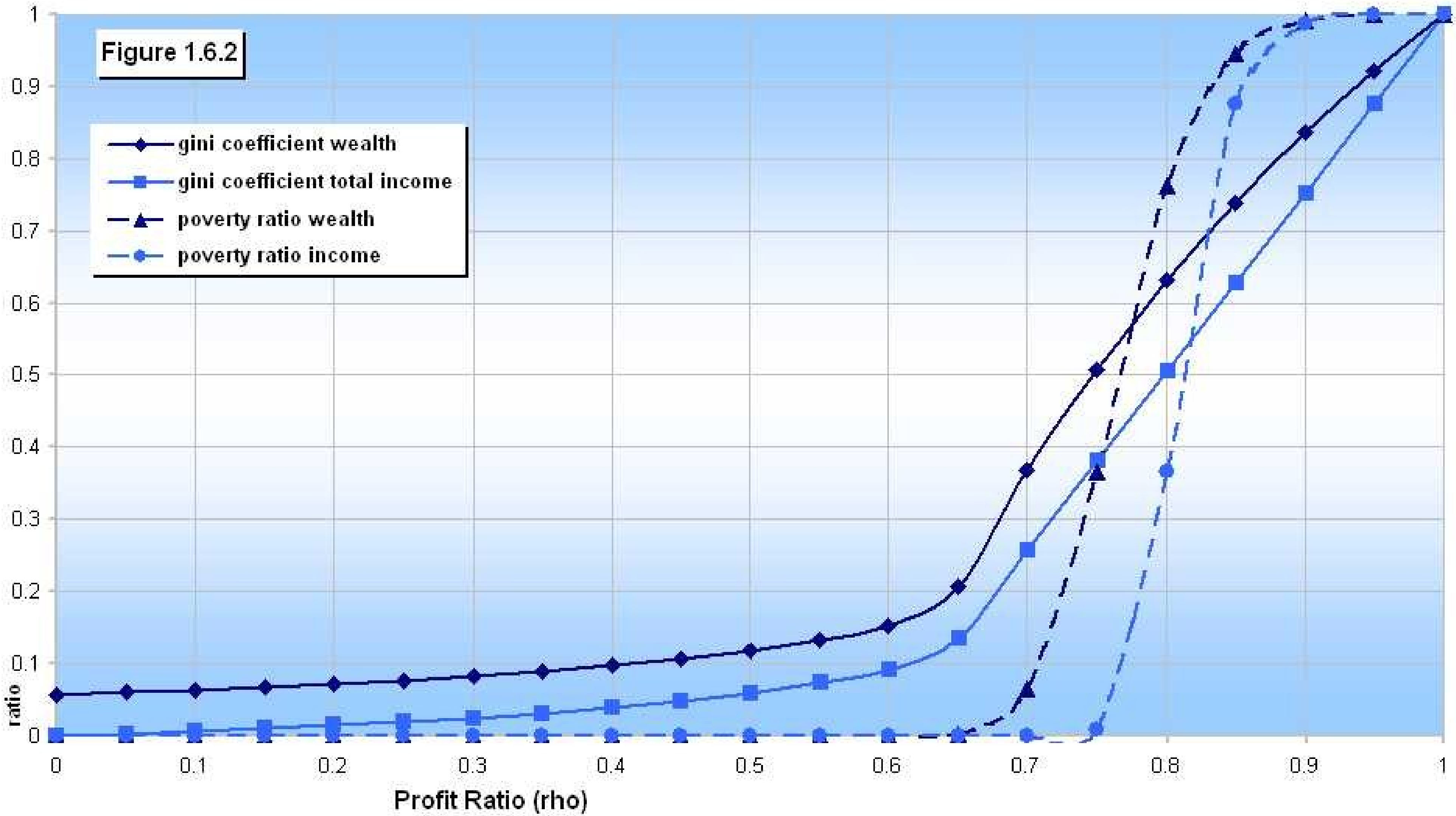
- Apex grazer is Bill Gates, can graze on Murdoch as Murdoch companies use Windows software

- The more capital you have got, the more grazing you get to do.

Don’t need any of the following:

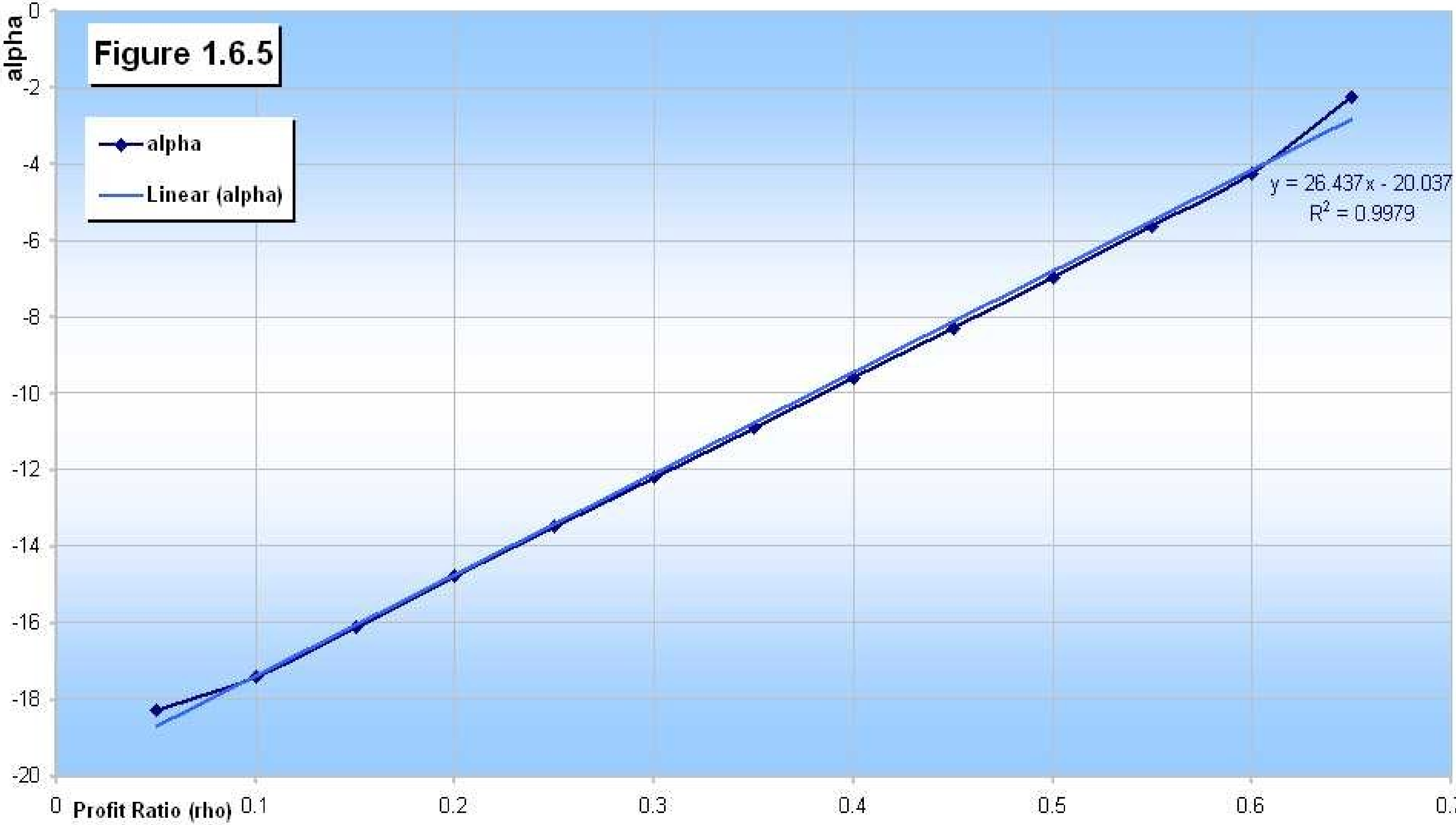
- Different initial endowments
- Savings rates that change with wealth
- Different earning potentials
- Economic growth
- Expectations (rational or otherwise)
- Behaviouralism
- Marginality
- Utility functions
- Production functions

1.6 Enter Sir Bowley - Labour and Capital



- Vary Bowley ratio / profit ratio

- when $\rho = 0$, $\beta = 1$, Gini index is zero
- when $\rho = 1$, $\beta = 0$, all earnings are returned as capital
  - the individual with the highest saving propensity, becomes the owner of all the wealth
  - Gini index goes to 1.



- power tail exponent for wealth varies linearly with profit ratio / Bowley ratio

- following formulae extracted empirically from data
  - (not proved analytically):

$$\alpha = \frac{1.36(1 - \rho)}{v^{1.15}} \qquad (1.6d)$$

$$\alpha = \frac{1.36\beta}{v^{1.15}} \qquad (1.6e)$$

v is the variance of the normal distribution of consumption rates

- increase in profit ratio / decrease in Bowley ratio has two effects on income distribution
    - simple change in income shares – bad
    - change slope of power tail – very, very, bad indeed
- Second effect much more important than first

- Power law appears to be result of two growth rates cf. [Newman 2005], which gives a general formula for α as:

$$\alpha = 1 - a/b \qquad (1.6f)$$

- In wealth model:

$$\text{Profit ratio} \qquad \rho = \frac{\text{direct returns to capital}}{\text{total income from capital}}$$

$$\text{Profit ratio} \qquad \rho = \frac{r}{\Gamma} \qquad (1.3w)$$

ρ is the growth rate that capitalists get on capital, divided by the growth rate that everybody (capitalists and workers) gets on capital.

1.7 Modifying Wealth and Income Distributions

1.7.2 Compulsory Saving

- If any agent's current wealth was less than 90% of the average wealth, that agent was obliged to decrease their consumption rate by 20 percent.

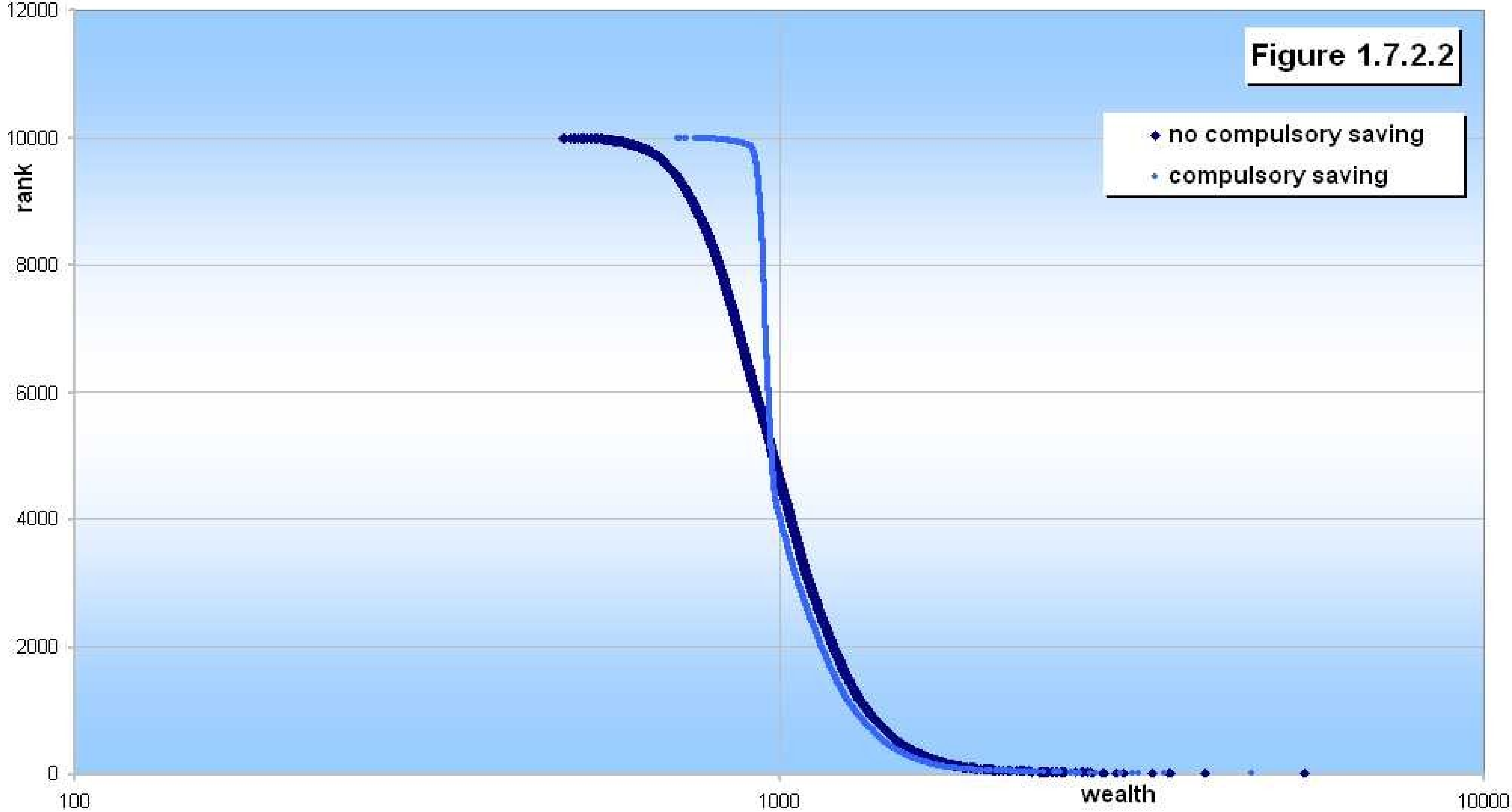


Figure 1.7.2.2
no compulsory saving
compulsory saving
rank
wealth
12000
10000
8000
6000
4000
2000
0
100
1000
10000

- Poverty largely eliminated
- still have power tail for the most talented
- rich are not taxed
- poor are compelled to save.

- In practise use system like Chilean / Australian compulsory pensions
- give extra assistance for low earners

2. Companies Models

- Allow W to differ from K
- Share prices can be different to company fundamental values
- shareholders are myopic – shares valued on previous dividends
  - as financial pricing:

$$\text{Present Value} = \frac{\text{Dividend}_1}{r}$$

r is the relevant market interest/profit rate; Dividend_1 is the latest dividend payment, and capital growth is ignored [Brealey et al 2008, chapter 5].

Other assumptions:

- managers of companies preserve the stability of dividend payouts
- managers act to preserve the capital of their companies
- liquidity, and so company size and book to market values are assumed to be irrelevant
- liquidity is constant throughout the modelling process
- risk is identical, and zero, for all companies in the model.
- Given above assumptions of zero risk and high liquidity; following Fama & French [Fama & French 1992], this leaves short term returns as the only factor that investors use to value companies.
- Note, are now looking at K(j) and w(j) (note, not w(i))

Figure 2.2.1

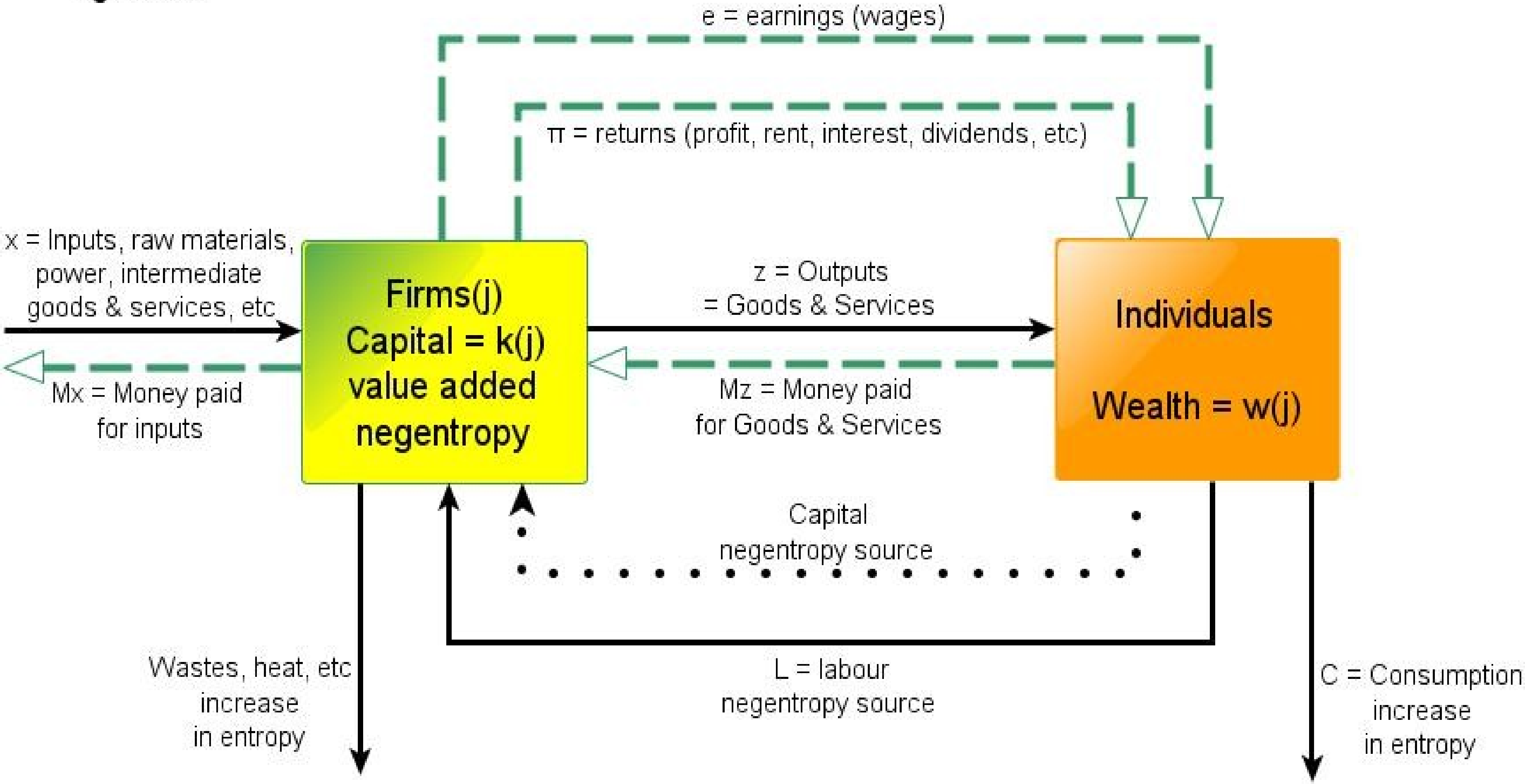
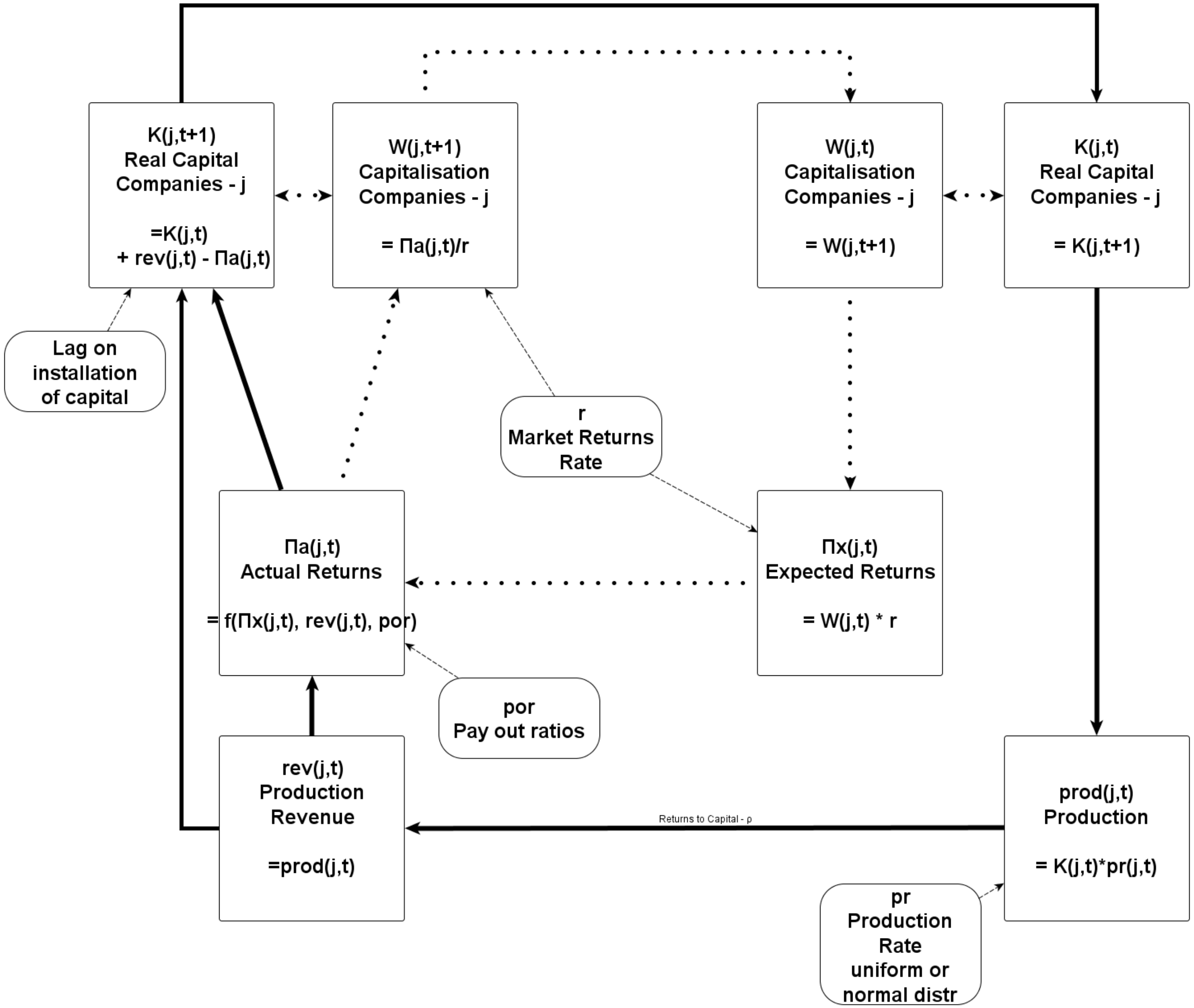

e = earnings (wages)
π = returns (profit, rent, interest, dividends, etc)
x = Inputs, raw materials, power, intermediate goods & services, etc
Firms(j)
Capital = k(j)
value added negentropy
z = Outputs
= Goods & Services
Individuals
Wealth = w(j)
Mx = Money paid for inputs
Mz = Money paid for Goods & Services
Capital negentropy source
Wastes, heat, etc increase in entropy
L = labour negentropy source
C = Consumption increase in entropy

Figure 2.2.2
Companies Model
Iteration Diagram



Two cycles for capital:

- 'Sraffian', 'real' capital cycle – black heavy arrows
  - production of commodities by means of commodities
  - 'real' goods with intrinsic value
- 'Minskian', 'financial' capital cycle – in dotted arrows
  - valuation by revenue stream
- key box is 'Actual Returns' πx
  - function of 'real' production, and
  - function of 'financial' expected returns

- So:
  - W(j,t) is a function of K(j,t), and
  - K(j,t) is a function of W(j,t)

- Gives a (General) Lotka-Volterra system with two different types of stock
  - Real capital K
  - Capitalisation W

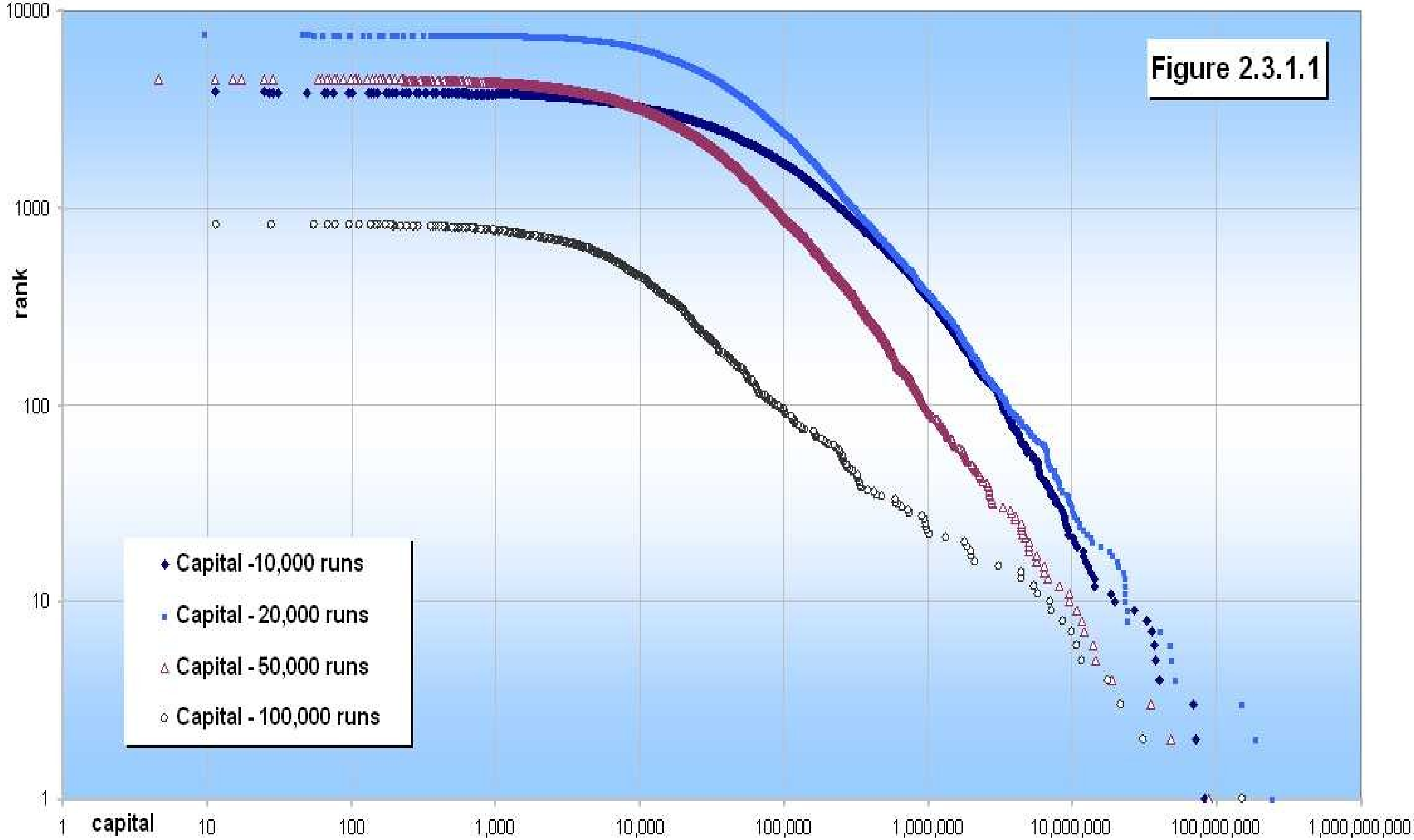
- Labour and earnings ignored
- Production rate; pr - defined distribution – uniform or normal
- market expected returns on capital; r – constant
- 'Capital hoarding' via 'payout ratios' – actual returns reduced to keep capital in company

Formula for iterations:

$$K_{j,t+1} = K_{j,t} + K_{j,t}\,\mathrm{prodrate}_{j,t} - f([W_{j,t}r],[K_{j,t}],\mathrm{por})$$

$$W_{j,t+1} = \frac{1}{r}\, f([W_{j,t}r],[K_{j,t}],\mathrm{por})$$

2.3.1 Model 2A Fully Stochastic on Production, No Capital Hoarding



- Production rate stochastic, same for each company over long run
- No capital hoarding

- **Companies are identical**

- **produces power tail distribution from identical companies**

- power tail correct value; approx = 1

- fails over long term, as companies removed from low end of distribution

- Capital hoarding produces stable models, but wrong power exponent
- Ian Wright models produce better models – from similar assumptions – uses company removal and formation

- Markets inefficient

- poorly performing companies downgraded until returns equals capitalisation – not eliminated

- value investors can spot these companies - Graham/Buffet strategy explained

Don't need:

- Economic growth
- Population changes
- Technology changes
- Different initial endowments (of capital)
- Shocks (exogenous or endogenous)
- Marginality
- Utility functions
- Production functions

3. Commodity models

Commodities – oil, copper, coffee, etc

- characterised by long term low prices with occasional large spikes
- demand stable and price insensitive
- non-substitutable
- long delays to installing new capital

- need dynamics not comparative statics
- demand fixed constant

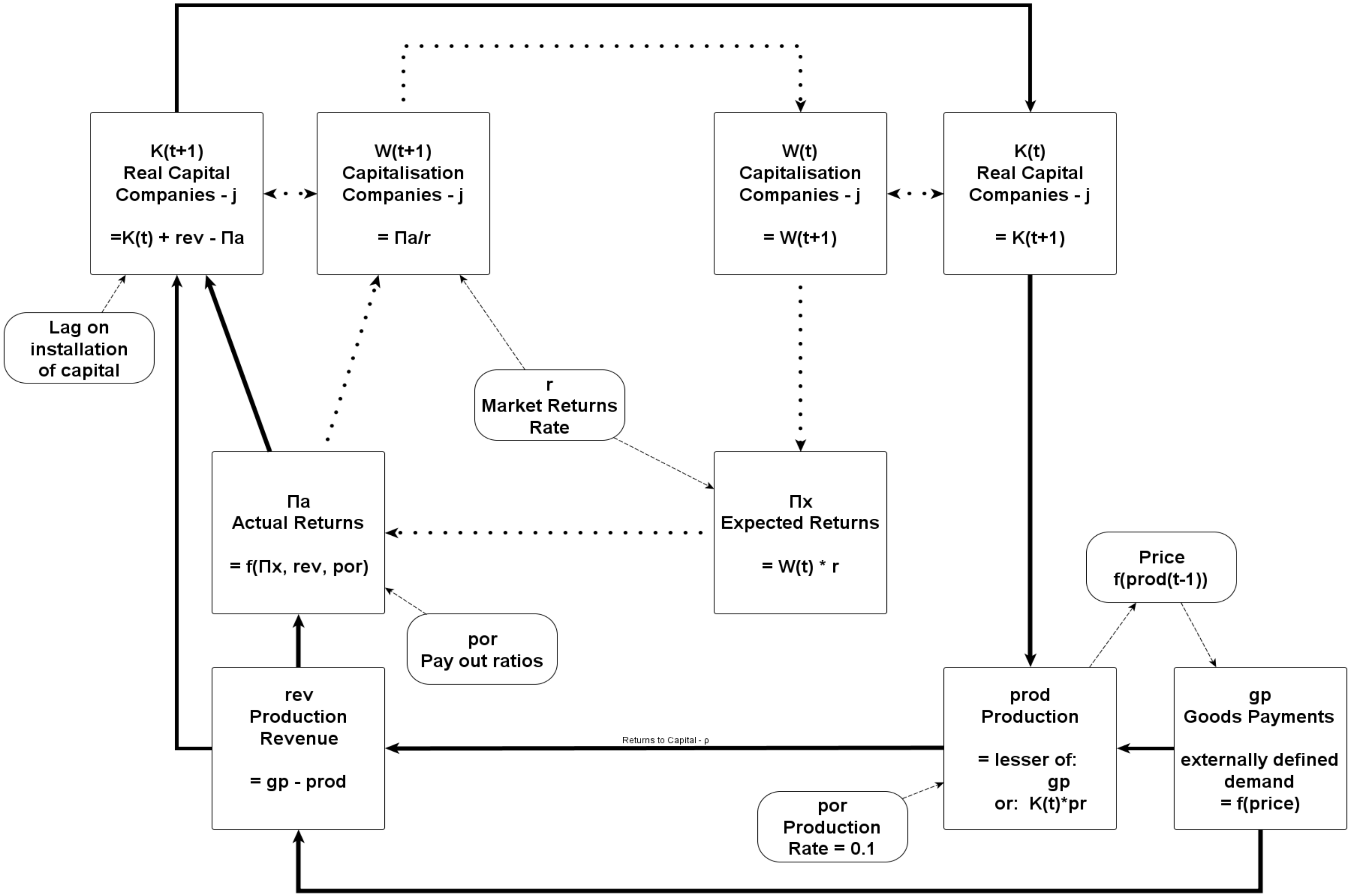
- use copper (not oil), so costs of commodity don't effect economy as a whole

- then input costs are independent of commodity price

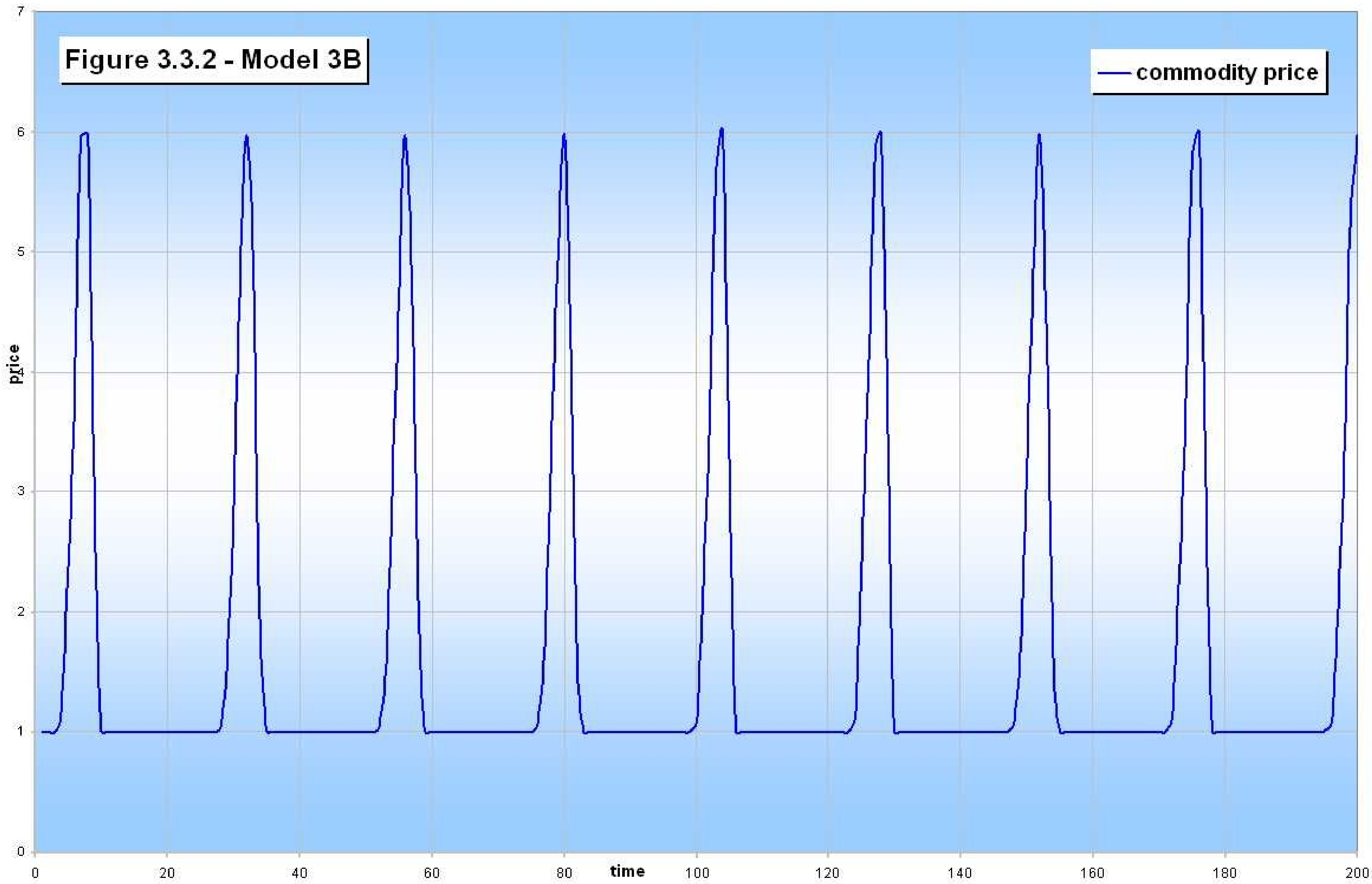
- input costs, labour and machines, are linear function of production

- price is highly dependent on supply
  - if supply more than demand; price is input cost
  - if supply less than demand; price rises rapidly

Figure 3.2.2
Commodities Model
Iteration Diagram



Results – lag on installation of capital, no capital hoarding:



- unstable system
- wide cyclical variations in prices
- real price of copper, based on inputs, should be 1 unit
    - only at bottom of cycle.

- behaviour is chaotic, not stochastic. Random changes are generated endogenously. No stochastic generator in this model
- Lotka-Volterra model, not a General Lotka-Volterra model
- build up of capital is too much for the economy to support
- build up of capital in the commodity sector is inherently unstable

- problems are deep in the maths of the system
- blaming investors or speculators for misjudging their investments is as sensible as blaming foxes for procreating when there are a lot of rabbits

- Diminishing returns and marginality are not necessary.
- model does not average to the correct input prices even over the long term
- correct input prices are instead associated with the bottoms of the cycles.
- market is inefficient. Average prices are substantially higher than they would be if they had the opportunity to settle to long-term static 'cost-plus' prices.

4. Minsky goes Austrian à la Goodwin – Macroeconomic Models

Assume:

- produced goods have real intrinsic values
- market prices can vary from these values
- Consumption is a fixed proportion of consumers’ paper wealth, as income models
- Companies have real capital which can produce a fixed proportion of output, and needs a proportional supply of labour, as all models above.

- price of paper wealth assets is defined by the preceding revenue stream; as in the myopic companies model above.
- management in companies can be capital preserving, as companies model above.
- can be delays in installing capital as commodities model above.
- population is constant
- technology productivity is constant. Production rate is fixed; production is proportional to real capital installed.

- Labour required is proportional to real capital installed

- The price of labour is non-linear according to supply. That is real wage rates go up when there is a shortage of labour, and go down when there is a surplus of labour. Labour is a genuinely scarce resource.
    - Labour behaves like a 'commodity'

- If demand is less than amount of goods that can be provided (with current installed capital) then price of goods is input costs

- If demand is greater than amount of goods that can be provided, then cash paid is shared amongst goods available. So have temporary goods price inflation, and super-profits for companies – used to install more capital

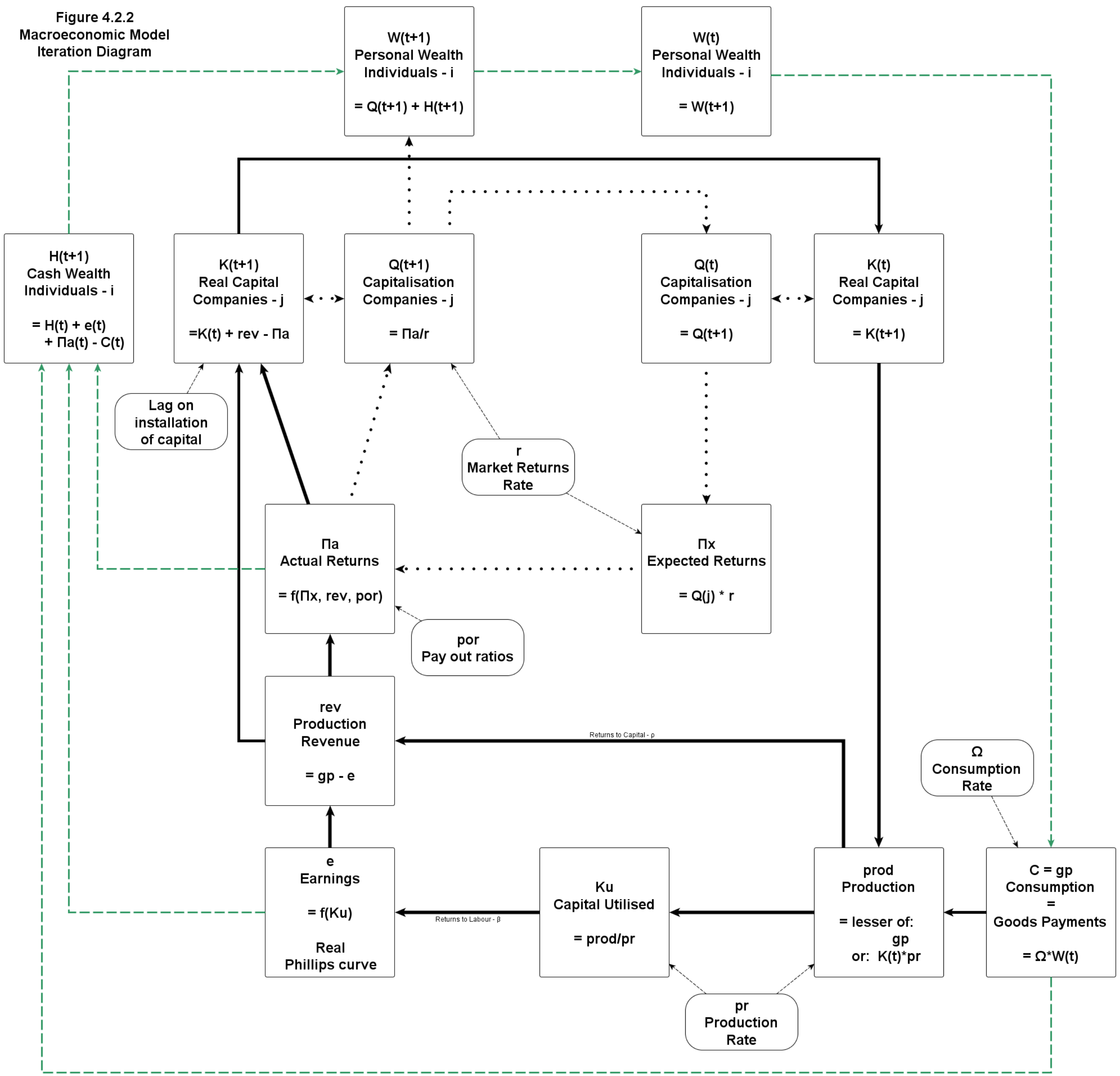
- Consumers can receive more income than they spend in consumption, alternatively can spend less.
  - So have a cash-balance H for excess income
  - assumed held in non invested cash account – non realistic
  - if H +ve, consumers have spare cash
  - if H -ve, consumers have debts

- total wealth W is the sum of the capitalisation Q (was W previously) and cash-balance H, so:

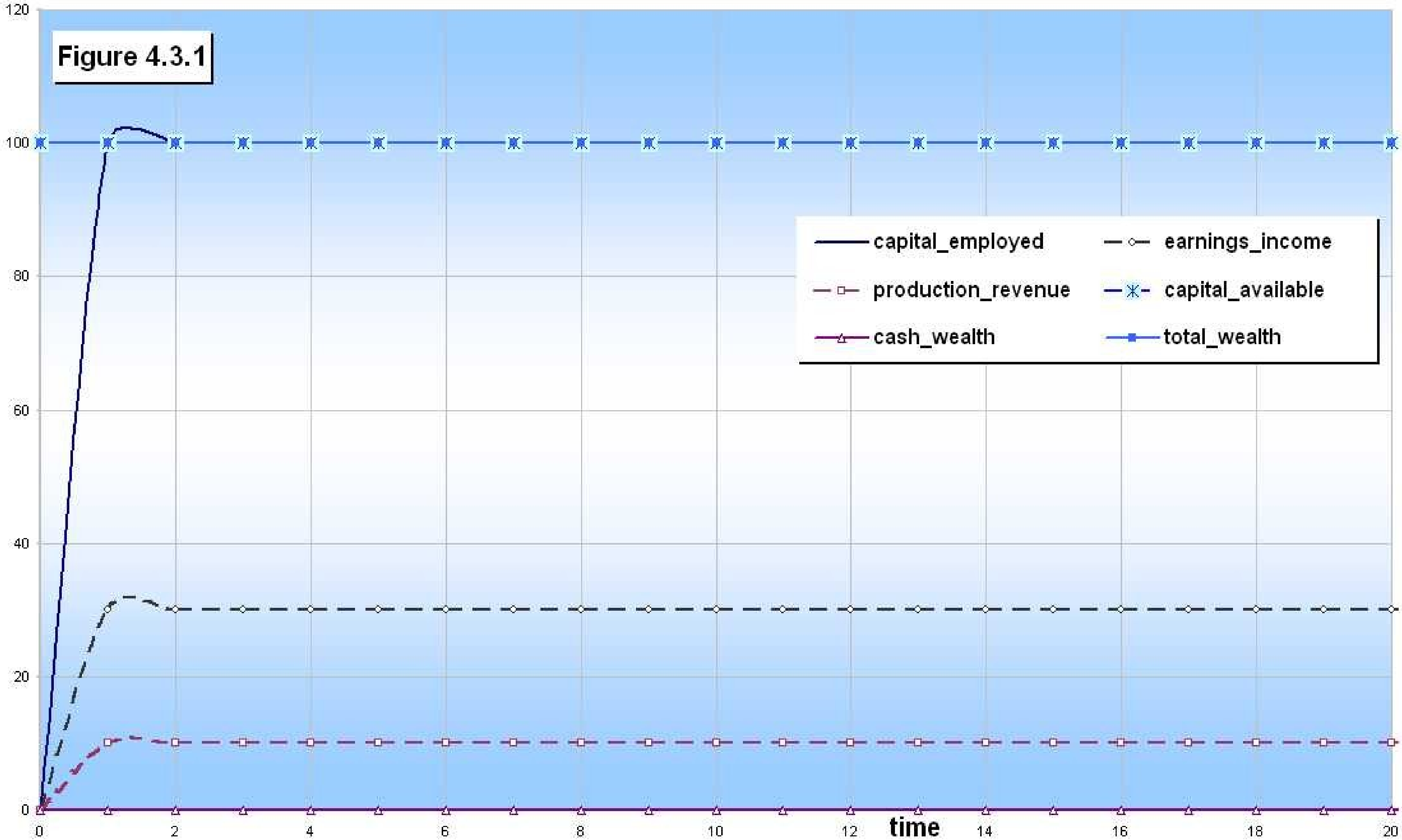
$$C = W\Omega \qquad (4.2a) \qquad \text{or:}$$

$$C = (Q + H)\Omega \qquad (4.2b)$$

Figure 4.2.2
Macroeconomic Model
Iteration Diagram



• Model can show stable or complex behaviour:



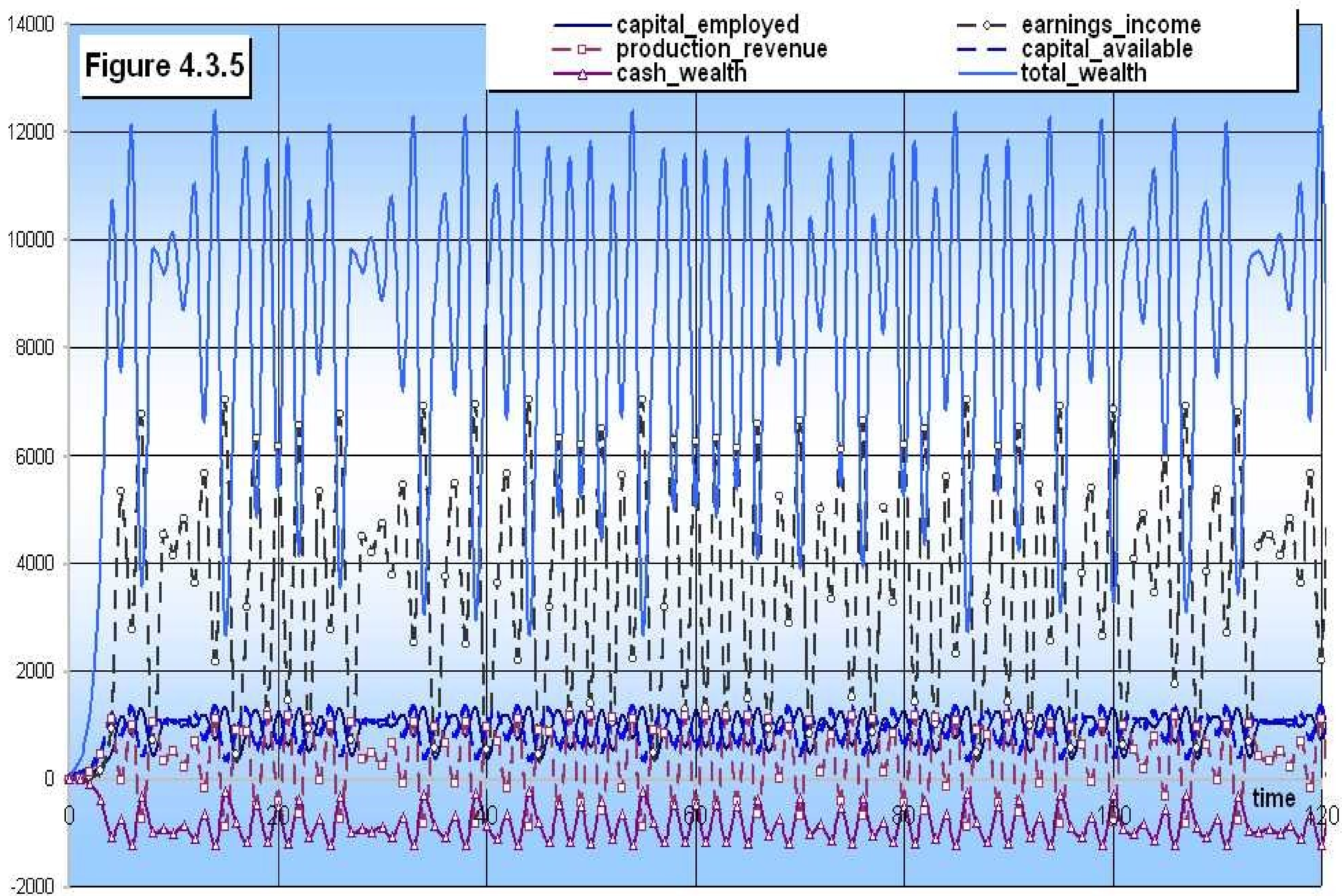


Figure 4.3.5
capital_employed
production_revenue
cash_wealth
earnings_income
capital_available
total_wealth
14000
12000
10000
8000
6000
4000
2000
0
-2000
0
20
40
60
80
100
120
time

- even with simple behaviour long term equilibrium can be very different according to initial conditions

  - Dynamic systems can have many different equilibiria
  - Keynes was right – economy does not balance automatically

Bowley ratios from the models:

Figure 4.3.7	β
Model 4A	0.75 (exactly)
Model 4B	0.92
Model 4C	0.78
Model 4D	0.85

Don't need:

- Stochasticity (in any form) (model is chaotic, not stochastic)

- Economic growth
- Population changes
- growth in labour force
- Technology changes
- Productivity growth
- Investment
- Saving
- Accelerators
- Multipliers

Also don't need:

- inflation (long-term)
- Shocks (exogenous or endogenous)
- Different initial endowments (of capital or wealth)
- Utility functions
- Production functions
- governments
- fiat money
- fractional reserve banking
- speculators
- Ponzi finance
- debt deflation

- **Basic instability due to pricing of paper assets on future cash flow**
  - **So W can be different to K**
  - Minsky and the Austrians were right
  - Creation of liquidity and monetary growth are endogenous to the basic pricing mechanisms of the finance system.
  - Endogenous creation of financial wealth feeds back into the creation of more real capital
    - so creating more financial wealth.
    - So creating more real capital
    - etc
  - endogenous creation of financial wealth gives apparently secure paper assets against which debt can be secured
    - debt allows yet more capital creation.

4.5 A Present for Philip Mirowski? – A Bowley-Polonius Macroeconomic Model

"I mean the stability of the proportion of national dividend accruing to labour, irrespective apparently of the level of output as a whole and of the phase of the trade cycle. This is one of the most surprising, yet best-established, facts in the whole range of economic statistics........ Indeed...the result remains a bit of a miracle." [Keynes 1939]

"...no hypothesis as regards the forces determining distributive shares could be intellectually satisfying unless it succeeds in accounting for the relative stability of these shares in the advanced capitalist economies over the last 100 years or so, despite the phenomenal changes in the techniques of production, in the accumulation of capital relative to labour and in real income per head." [Kaldor 1956]

- The source of the value of the Bowley ratio in the model was investigated empirically

- while holding the cash balance at zero; the following formula was 'discovered' from the model:

$$\begin{aligned} \beta &= \text{Bowley ratio} \\ &= 1 - \frac{r}{\Omega} \qquad (4.5k) \end{aligned}$$

- this can be derived trivially:

$Y = e + \pi \quad \Rightarrow$ by definition, so: $\quad e = Y - \pi$

$\dfrac{e}{Y} = 1 - \dfrac{\pi}{Y} \quad \Rightarrow$ so: $\quad \beta = 1 - \dfrac{\pi}{Y}$ but:

Consumption $=$ Income $\quad \Rightarrow \quad C = Y$ so:

$\beta = 1 - \dfrac{\pi}{C}$ or:

$\beta = 1 - \dfrac{\pi / W}{C / W}$ so:

$$\beta = 1 - \frac{r}{\Omega}$$

- The proportion of returns to labour is determined macroeconomically by consumption / savings rates.
- Not determined by production functions
- consumption rates are near constant and are exogenous.
- the consumption rate Ω defines Γ; the ratio of total income to capital.
- r is smaller than Ω - gives Bowley ratio between 0.5 and 1.0 – matches real values

- data from Young [Young 2010] shows
  - the relative shares accruing to labour and capital can change quite significantly within individual sectors
  - shares to labour have decreased significantly in manufacturing and agriculture
  - meanwhile shares to labour have increased significantly in services
  - overall shares to labour fairly constant

  - all the cappucino bars and hairdressers have been created to keep the shares to labour in balance with consumption rates

4.6 Unconstrained Bowley Macroeconomic Models

- If the cash-balance balance is allowed to change from zero, then Bowley ratio given by:

$$\rho = \frac{rQ}{\Omega(Q + H)}$$

$$\beta = \frac{\Omega + \Omega(H/Q) - r}{\Omega + \Omega(H/Q)}$$

$$= \frac{1 + (H/Q) - (r/\Omega)}{1 + (H/Q)} \qquad (4.6a)$$

- also trivial to derive from basic algebra

- If the cash balance is positive and increasing; Bowley's ratio heads closer to unity, good for workers, bad for capitalists.

- if H is negative (a debt) and the size of the debt is increased, then the size of both the numerator and denominator reduce, however the value of the numerator reduces more rapidly than the size of the denominator, and the Bowley ratio slowly decreases.

- (At least at first.)

- If debt is allowed to continue increasing, then the Bowley ratio drops rapidly to zero, and then shortly afterwards heads off to negative infinity.

- In the model it isn't possible to reach these points; as the Bowley ratio heads to zero the model becomes unstable, and explosive

  - the economy blows up in an bubble of excess real capital and even more excess debt.

    - *This may sound familiar.*

Note also:

- value of H has a direct effect on Bowley ratio β in eq 4.6(a)

- β has a direct effect on alpha, the exponent of the power tail in the wealth distribution in eq 1.6(e).

- So, levels of debt have a direct effect on wealth inequality

- More realistically, do something with the cash H, change to savings S
- Banks take in savings S and lend to companies.
- Receive interest on loans at R
  - (equivalent rate to dividends R = Π/Q)
- Pay interest to public at r.

Then:

$$\rho = \frac{RQ + rS}{\Omega(Q + S)}$$

- Same conclusions arise regarding debt as above.

Conclusions

- Simple model explains
  - wealth / income distributions
  - company size distributions
  - macroeconomic cycles
  - ratio of returns to capital and labour

- Biologists have the right models

Further reading:

- econodynamics.org