Fields Institute Seminars

Tuesday June 12th 2012

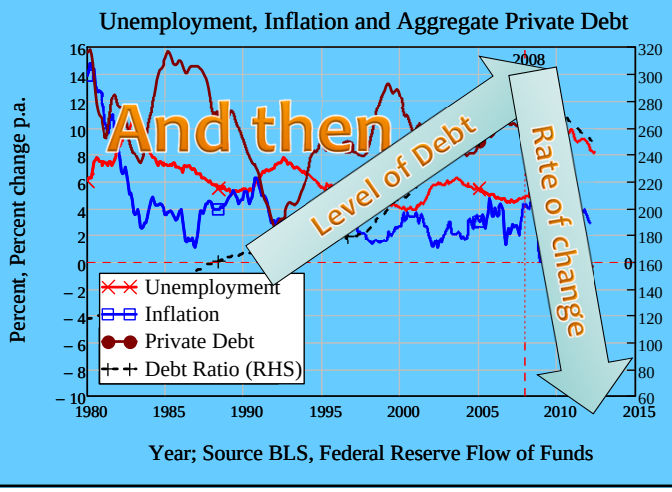
A Monetary Minsky Model

Typical neoclassical forecast in 2007

- ***"the current economic situation is in many ways better than what we have experienced in years…***
- **Our central forecast remains indeed quite benign:**
  - a soft landing in the United States,
  - a strong and sustained recovery in Europe,…
  - In line with recent trends, **sustained growth in OECD economies would be underpinned by strong job creation and falling unemployment.**" (p. 9)
    - OECD Chief Economist Jean-Philippe Cotis 2007
    - Based on OECD "small macroeconomic model"

Neoclassical Economics & The Lesser Depression

- "the past two decades has seen not only significant improvements in economic growth and productivity but also a marked reduction in economic volatility… dubbed "the Great Moderation." (Bernanke 2004)



- Factors they ignored:
- Factors central to Minsky's Financial Instability Hypothesis

A Primer on Minsky

- Part of non-Neoclassical stream in economics that takes banks, debt & money seriously
- Firstly ignored by Neoclassical economists:
  - "Minsky … argued for the inherent instability of the financial system but … departed from the assumption of rational economic behaviour…
  - I do not deny the possible importance of irrationality in economic life; however it seems that the best research strategy is to push the rationality postulate as far as it will go." (Bernanke 2000, p. 43)
- Now misinterpreted by them (Krugman & Eggertsson 2010)
  - "A Fisher-Minsky-Koo approach"?
    - Equilibrium DSGE model
    - Without endogenous money or banks
    - Where aggregate debt doesn't matter (only distribution)

A Primer on Minsky

- In general rejection of Neoclassical model:
  - "The abstract model of the neoclassical synthesis cannot generate instability.
  - When the neoclassical synthesis is constructed,
    - capital assets,
    - financing arrangements that center around banks and money creation,
    - constraints imposed by liabilities, and
    - the problems associated with knowledge about uncertain futures
  - are all assumed away.
  - For economists and policy-makers to do better we have to abandon the neoclassical synthesis." (Minsky 1982 , p. 5)

A Primer on Minsky

- In particular (from Fisher & Schumpeter as well as Minsky):
  - ***Disequilibrium***
    - "Theoretically there must be over or under everything…
    - *It is as absurd to assume that the variables in the economic organization, or any part of them, will "stay put," in perfect equilibrium, as to assume that the Atlantic Ocean can ever be without a wave." (Fisher 1933, p. 339)*
- "Stable growth is inconsistent with an economy in which debt-financed ownership of capital assets exists. ***It follows that …***
- ***the fundamental instability of a capitalist economy is upward.***
- The tendency to transform doing well into a speculative investment boom is the basic instability in a capitalist economy." (Minsky 1982)

A Primer on Minsky

- ***Endogenous money and banks*** (Schumpeter 1934, p. 73)
- Banks matter because they create spending power "out of nothing"
- Finances investment (good)…
  - "the conventional answer is ***not obviously absurd***,
  - yet there is another method of obtaining money…
  - ***the creation of purchasing power by banks…***
  - It is not transforming purchasing power which already exists
  - but the creation of new purchasing power ***out of nothing***."
- Confirmed by Fama-French empirical work:
  - "These correlations confirm the impression that debt plays a key role in accommodating year-by-year variation in investment." (Fama and French 1999, p. 1954)
  - "Debt seems to be the residual variable in financing decisions. Investment increases debt, and higher earnings tend to reduce debt." (draft version)

A Primer on Minsky

- Minsky: growing ***aggregate*** private debt source of economic growth
  - "If income is to grow, the financial markets must generate an aggregate demand that is ever rising.
  - For real aggregate demand to be increasing, it is necessary that current spending plans be ***greater*** than current received income and
  - that some market technique exist by which ***aggregate spending in excess of aggregate anticipated income*** can be financed.
  - ***It follows that over a period during which economic growth takes place, at least some sectors finance a part of their spending by emitting debt or selling assets.***" (Minsky 1982)
- Minsky: Rising debt also finances Ponzi behaviour & asset bubbles

A Primer on Minsky

- "Ponzi income falls short of interest payments on debt so that the outstanding debt will grow due to interest on existing debt… Ponzi units can fulfill their payment commitments on debts only by borrowing… a Ponzi unit must increase its outstanding debts.' (Minsky 1982, p. 24)
- Ponzi debt drives up asset prices:
- "During a period of tranquility, there will be a decline in the value of the insurance that the holding of money bestows.
- This will lead to a rise in the price of capital assets so that a larger admixture of Ponzi finance is accepted by bankers.
- In this way ***the financial system endogenously generates at least part of the finance needed by the increased investment demand*** that follows a rise in the price of capital assets." (Minsky 1982, p. 107)
  - Endogenous money & banks funding Ponzi Schemes
    - Essential parts of Minsky's model of capitalism:

The Financial Instability Hypothesis

- Economy in **historical *time***
- Debt-induced recession in recent past
- Firms and banks conservative re debt/equity, assets
- Only conservative projects are funded
  - Recovery means most projects succeed
- Firms and banks revise risk premiums
  - Accepted debt/equity ratio rises
  - Assets revalued upwards…
- "Stability is destabilising"
  - Period of tranquility causes expectations to rise…
- Self-fulfilling expectations
  - Decline in risk aversion causes increase in investment
  - Investment expansion causes economy to grow faster
- Rising expectations leads to "The Euphoric Economy"…

The Financial Instability Hypothesis

- Asset prices rise: speculation on assets profitable
- Increased willingness to lend increases money supply
  - Money supply endogenous, not controlled by CB
    - Riskier investments enabled, asset speculation rises
- The emergence of "Ponzi" financiers
  - Cash flow less than debt servicing costs
  - Profit by selling assets on rising market
  - Interest-rate insensitive demand for finance
- Rising debt levels & interest rates lead to crisis
  - Rising rates make conservative projects speculative
  - Non-Ponzi investors sell assets to service debts
  - Entry of new sellers floods asset markets
  - Rising trend of asset prices falters or reverses

The Financial Instability Hypothesis

- Boom turns to bust
- Ponzi financiers first to go bankrupt
  - Can no longer sell assets for a profit
  - Debt servicing on assets far exceeds cash flows
- Asset prices collapse, increasing debt/equity ratios
- Endogenous expansion of money supply reverses
- Investment evaporates; economic growth slows
- Economy enters a debt-induced recession
  - Back where we started…
- Process repeats once debt levels fall
  - But starts from higher debt to GDP level
- Final crisis where debt burden overwhelms economy
  - Modeling Minsky ***with money…***

A monetary model of Minsky

- Need to link 1995 implicit money model
  - Debt finances investment in excess of profits
  - But no explicit monetary flows:

Wages share of output $\frac{d\omega}{dt} = \omega \times (w(\lambda) - \alpha)$

Employment ratio $\frac{d\lambda}{dt} = \lambda \times \left(\frac{k(\pi)}{v} - \gamma - \alpha - \beta \right)$

Debt to output ratio $\frac{dd}{dt} = \left(r - \left(\frac{k(\pi)}{v} - \gamma \right) \right) \times d + k(\pi) - \pi_s$

Subsidy to output ratio $\frac{dg}{dt} = g \times \left(g(\lambda) - \left(\frac{k(\pi)}{v} - \gamma \right) \right)$

Profit is now net of government: $\pi = 1 - \omega - r \times d + g$

- With post-2006 explicit monetary models without production

A monetary model of Minsky

- Basic monetary model has two links to production:

$DEB_2 :=$

"Private Banks"	"Columns"	2	3	4	5	6	7	8
"Rows"	"Type"	∞	1	0	−1	−1	−1	−1
2	"Account"	"Licence"	"Firm Loan"	"Bank Vault"	"Firm Dep"	"Worker"	"Sholder"	"Bank Safe"
3	"Initial Value"	Licence	0	−Licence	0	0	0	0
4	"Symbol"	$B_C(t)$	$F_L(t)$	$B_V(t)$	$F_D(t)$	$W_D(t)$	$S_D(t)$	$B_S(t)$
5	"Working Capital"	0	0	WC	−WC	0	0	0
6	"Record Loan"	−WC	WC	0	0	0	0	0
7	"Charge Interest"	0	0	Int	0	0	0	−Int
8	"Record Interest"	−Int	Int	0	0	0	0	0
9	"Pay Interest"	0	0	−Int	Int	0	0	0
10	"Record Payment"	Int	−Int					
11	"Wages"	0	0					
12	"Divs"	0	0	0	Div	0	−Div	0
13	"Consume"	0	0	0	$-Con_W$	Con_W	0	0
14	"Consume"	0	0	0	$-Con_B$	0	0	Con_B
15	"Consume"	0	0	0	$-Con_S$	0	Con_S	0
16	"Repay Firm"	0	0	−Repay	Repay	0	0	0
17	"Record Repay"	Repay	−Repay	0	0	0	0	0
20	"Expand Assets"	Invest	0	−Invest	0	0	0	0

Wages determine employment

Investment determines capital stock & real output

A monetary model of Minsky

- First step—what are wages?
- Last week's model—wages simply a flow from Firm's account to workers
  - Showing the same in … Minsky:
    - Dynamic monetary program developed with INET grant
    - Contains a "Godley Table" as does QED:

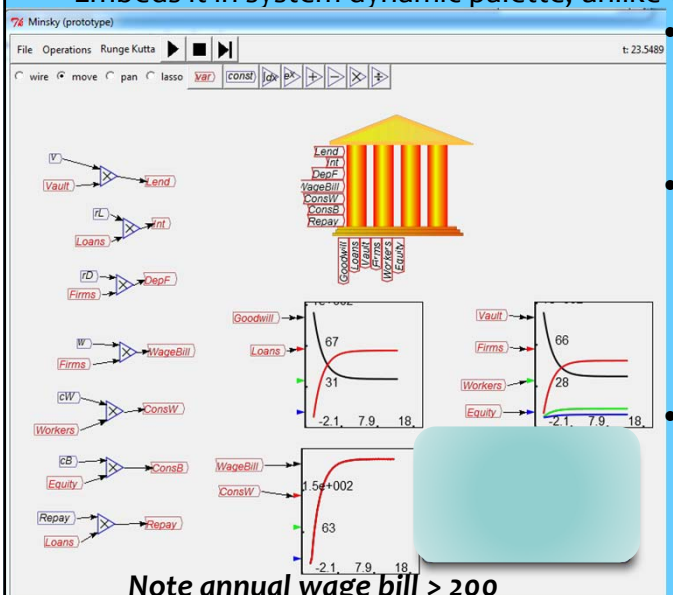
Godley Table

Flows V / Stock Variables ->	Goodwill	Loans	Vault	Firms	Workers
Initial Conditions				0	0
Lend			-Lend	Lend	
Record	-Lend	Lend			
Charge			-Int		
Record	-Int	Int			
Pay Interest			Int	-Int	
Record Payment	Int	-Int			
Deposit Interest				DepF	
Hire Workers				-WageBill	WageBill
Consume				ConsW	-ConsW
Consume				ConsB	
Repay			Repay	-Repay	
Record Repayment	Repay	-Repay			

Note initial money stock = 100

A monetary model of Minsky

- Embeds it in system dynamic palette, unlike QED



Note annual wage bill > 200

- Flow of wages p.a. is workers' monetary share in net output p.a.
- Have to specify
  - How net output divided up
  - Time dynamics
  - How net output produced
- Requires shares of output, time dimension of output, model of physical output

A monetary model of Minsky

- Shares:
  - Part to capitalists (s)
  - Part to workers (1-s)
    - Income of financial sector just a transfer
      - Loan deposit rate spread; size of loan, deposits
- Time dimension: "turnover period"
- Marx's description of the "Turnover of capital":
  - "The total productivity of capital is = the duration of one production phase multiplied by the number of times it is repeated in a certain period of time". (Grundrisse, p. 630)
- ***Turnover period*** determined by production/supply issues
    - Time taken to transform inputs into outputs
  - As well as monetary/demand issues
    - Time taken to sell outputs and generate revenue

A monetary model of Minsky

- Call turnover period τ_S
  - Fraction of a year that it takes to go from M to M+
    - *Time between initial outlay (loan from bank, used to hire workers, pay wages) & receiving money from sale of output*
- Call capitalist share of surplus ***s***
  - Then workers get ***(1-s)***
- So w = $(1-s)/\tau_S$
  - And wages are $((1-s)/\tau_S).F_D$
- Production: start with:
  - Single Output (**Q** or "GDP")
  - Labour input **L**
  - Constant labour productivity (**a**) so that
    - **Q** = **a.L**
  - Constant money wage **W**

A monetary model of Minsky

- To link **physical** output
- With **monetary** model developed in last lecture
  - We need a Price level (**P**)
    - Have to work out a ***dynamic*** equation for price…
    - We start—but don't end!—with price in equilibrium:

A monetary model of Minsky

- In equilibrium, price must just enable flow of demand to purchase flow of output
  - Flow of output is
  - **Q = a.L**
  - **L** equals flow of wages divided by wage rate
    - Flow of wages is

Worker's share of surplus generated in production

$$\frac{1-s}{\tau_s} \cdot F_D$$

Time lag between financing production and receiving sales revenue

Balance in Firm sector's deposit account

A monetary model of Minsky

- So number of workers employed **L** is this flow divided by the wage rate **W:**

$$L = \frac{1-s}{\tau_s} \cdot F_D \div W$$

- Physical output **Q** is then labour employed **L** multiplied by labour productivity per worker **a:**

$$Q = a \cdot L = a \cdot \frac{1-s}{\tau_s} \cdot \frac{F_D}{W}$$

- Physical demand (**D**) is the monetary flow of demand divided by the price level P
- Monetary flow of demand is $\frac{F_D}{\tau_s}$

A monetary model of Minsky

- So demand in physical units per year is this divided by price level **P:**

$$D = \frac{F_D}{\tau_s} \div P$$

- When economy is in equilibrium, flow of supply will equal flow of demand:

$$D_{Eq} = \frac{F_{D_{Eq}}}{\tau_s} \div P_{Eq} = Q_{Eq} = a \cdot \frac{1-s}{\tau_s} \cdot \frac{F_{D_{Eq}}}{W}$$

- We can now solve for what Price would be in equilibrium:

$$P_{Eq} = \frac{\text{Cancel}}{\text{Cancel}} \div a \cdot \frac{1-s}{\text{Cancel}} \cdot \frac{\text{Cancel}}{W} \qquad P_{Eq} = \frac{1}{1-s} \frac{W}{a}$$

A monetary model of Minsky

- In equilibrium, price a markup on monetary cost of production:

Markup: 1/(1-s) is bigger than 1

$$P_{Eq} = \frac{1}{1-s}\frac{W}{a}$$

Money wage per worker divided by units of output per worker is the cost of production per unit produced

- Price as a markup on cost of production means that
  - *Prices convert the physical surplus into a monetary one*
- Basic dynamic price equation consistent with this is:

Time lag in price setting

Rate of change of prices

Relation in Equilibrium

$$\frac{dP}{dt} = -\frac{1}{\tau_P}\left(P - \frac{1}{1-s}\frac{W}{a}\right)$$

A monetary model of Minsky

- Minimum production system is therefore:

$$Q = a \cdot L$$

$$L = \frac{1-s}{\tau_S} \cdot \frac{F_D}{W}$$

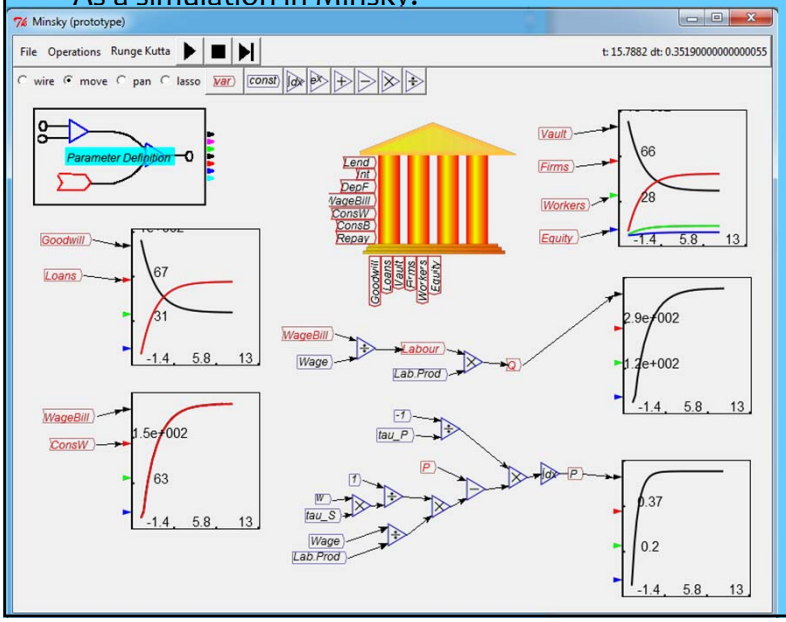
$$\frac{dP}{dt} = -\frac{1}{\tau_P}\left(P - \frac{1}{1-s}\frac{W}{a}\right)$$

- Monetary-production model is
  - This physical system
  - Coupled with previous monetary flows table

Type of Account	Asset		Liability		Income
Name	Bank Reserve	Firm Loan	Firms	Households	Bank
Symbol	B_R	F_L	F_D	H_D	B_D
Compound Interest		A			
Deposit Interest			+B		-B
Pay Interest		-C(=-A)	-C		+C
Pay Wages			-D	+D	
HH Interest				+E	-E
Consume			F+G	-F	-G
Repay Debt	+H	-H	-H		
Relend Reserves	-I	+I	+I		
Sum of flows	**H-I**	**I-H**	B+F+G+I-(C+D+H)	D+E-F	C-(B+E+G)

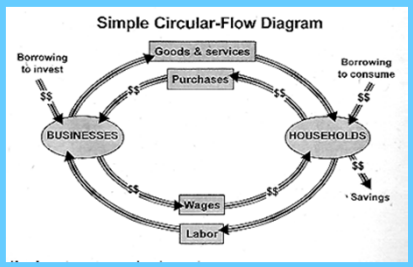
A monetary model of Minsky

- As a simulation in Minsky:



A monetary model of production

- Taking stock so far: Combining
  - Circuit insights into nature of credit money; and
  - Basic approach to dynamic modelling;
- Has yielded working model of "the circular flow"
  - Not just a diagram…



- But working model of monetary and physical flows
- No hassles about assuming equilibrium, etc.
- Next stages
  - Explain parameter values
  - Allow for growth; and
  - Beginnings of behaviour (rather than fixed parameters)

Parameter Values and Time Lags

- Values used for parameters may seem strange…
  - w=26 for workers consumption;
  - b=1 for bankers consumption
- Full list of values is:

$$\begin{pmatrix} r_D \\ r_L \\ s \\ \tau_S \\ \omega \\ \beta \\ L_R \\ R_R \end{pmatrix} = \begin{pmatrix} 0.01 \\ 0.05 \\ 0.25 \\ 0.25 \\ 26 \\ 1 \\ 0.143 \\ 2 \end{pmatrix}$$

- Interest rates based on long run averages
  - Loan minus deposit rates normally 4%
- Rate of surplus & turnover arbitrary
  - but generate income shares close to actual data
- Other 4 parameters (ω, β, L_R, R_R) are *inverse time constants*:
  - Time constants tells how long a process would take to reach its equilibrium if it continued linearly…
  - It's related to slope of a function at its initial point…

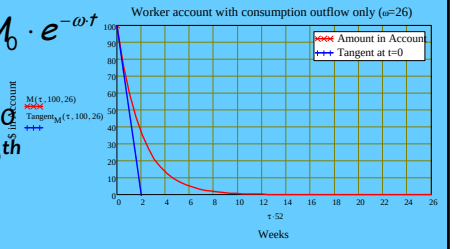
Parameter Values and Time Lags

- Consider just consumption
- Equation for outflow from account **M** is $\frac{1}{M}\cdot\frac{d}{dt}M = -\omega$
- Solve this via integration:

$$\frac{1}{M}\cdot\frac{d}{dt}M = -\omega \Rightarrow \frac{dM}{M} = -\omega\cdot dt \Rightarrow \int\frac{dM}{M} = \int -\omega\cdot dt$$

$$\ln(M) = -\omega\cdot t + C \Rightarrow M(t) = M_0\cdot e^{-\omega\cdot t}$$

- Graph for M_0=100, w = 26:
- *Notice that tangent to curve at t=0 crosses time axis at 2 weeks =* ***1/26th year = 1/w***



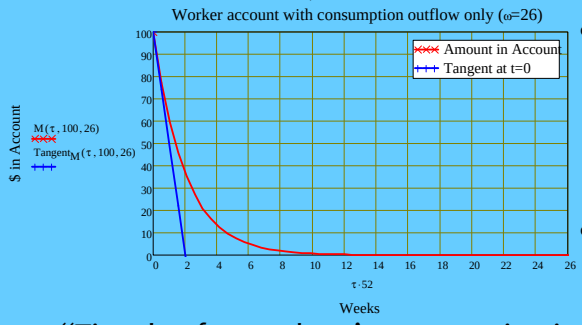
- Slope of tangent is derivative…

$$\frac{d}{dt}M(t) = \frac{d}{dt}M_0\cdot e^{-\omega\cdot t} \Rightarrow M_0\cdot\frac{d}{dt}e^{-\omega\cdot t} \Rightarrow M_0\cdot -\omega\cdot e^{-\omega\cdot t}$$

- At t=0, slope of tangent is $-\omega\cdot M_0\cdot e^{-\omega\cdot 0} = -\omega\cdot M_0 = -2600$

Parameter Values and Time Lags

- Equation of tangent to curve at t=0 is
- Equals M_0 at t=0 $M_0 \cdot (1 - \omega \cdot t)$ • Slopes away at w.M_0
- *Equals zero at* ***t=1/w*** *(in workers' case, 1/26th of a year)*

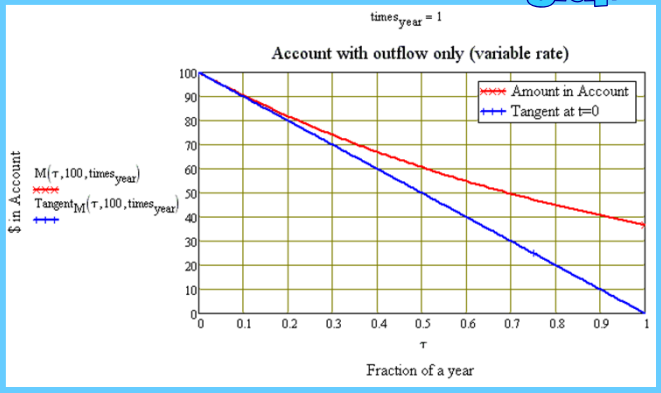


- Point where tangent to curve crosses zero gives convenient way to describe curve:
- Tangent hits zero at t=1/26

- "Time lag for workers' consumption is *1/26th of a year*"
  - τ_w=1/26 …
  - Same idea used for all other parameters:

Parameter Values and Time Lags

- Rule applies in general



- Time where tangent to curve crosses equilibrium value of function is the time lag of the function, expressed as fractions of the time unit (here, years)

Parameter Values and Time Lags

- Lets us interpret w as number of times a year workers "turnover" their accounts
  - "Workers spend their wages 26 times a year"
    - $\omega = 26$
- And express consumption by workers as a time lag
  - "Time lag for workers' consumption is
    - 2 weeks or 1/26th of a year"
    - $\tau_W = 1/26$
- So consumption from household accounts can be shown as

$$\frac{d}{dt}M = -\omega \cdot M \text{ where w = 26}$$

or

$$\frac{d}{dt}M = -\frac{1}{\tau_W} \cdot M \text{ where } t_w = 1/26$$

- *In practice, time lag version used, since it expresses behaviour in fractions of basic time unit of a year*

Parameter Values and Time Lags

- So the various "strange" parameter values mean:

Parameter	Value	Time Lag	Meaning
τ_S	¼	τ_S = ¼	"Production takes ¼ year to go from outlaying M on inputs to getting M+ from sales"
ω	26	τ_W= 1/26	"Workers turnover their account balances every 2 weeks or 1/26th of a year"
β	1	τ_B = 1	"Bankers turnover their accounts every year"
L_R	0.143	τ_{LR} = 7	"Loans are repaid every 7 years"
R_R	2	τ_{RR} = ½	"Banks relend reserves every 6 months or ½ year

- Time lags used from now on to better specify models

Variable wages

- Raises the vexed issue of the "Phillips Curve"…
  - Alleged statistical relationship between
    - Level of unemployment and
    - Rate of change of money wages
- Massively misinterpreted in literature & textbooks
  - Phillips was actually a systems engineer
    - Using 1950s version of technology shown here
    - Tried to introduce these methods to economics
      - Misinterpreted and derided as "Hydraulic Keynesianism"
    - Objective: to introduce dynamics into economics!

The Phillips Model…

- "RECOMMENDATIONS for stabilising aggregate production and employment have usually been derived from the analysis of multiplier models, using the method of comparative statics.
- This type of analysis does not provide a very firm basis for policy recommendations, for two reasons.
- First, the time path of income, production and employment during the process of adjustment is not revealed. It is quite possible that certain types of policy may give rise to undesired fluctuations, or even cause a previously stable system to become unstable, although the final equilibrium position as shown by a static analysis appears to be quite satisfactory.
- Second, the effects of variations in prices and interest rates cannot be dealt with adequately with the simple multiplier models which usually form the basis of the analysis." (Phillips 1954: 290)

The Phillips Model…

- Phillips built a *dynamic* model using flowchart: showed one variable (e.g., unemployment) affecting rate of change of another (e.g., money wages…)

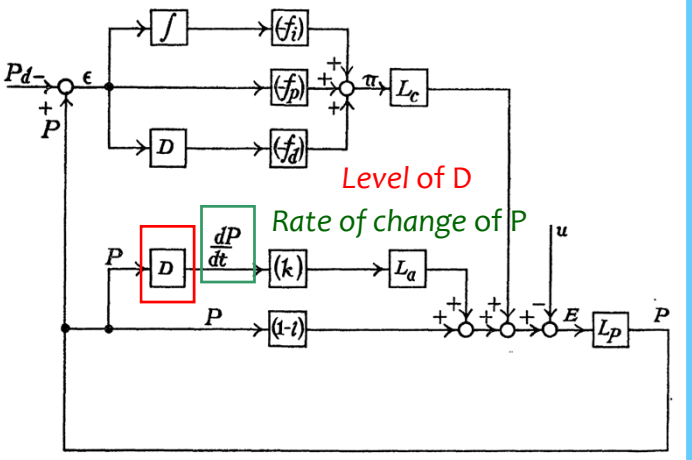


Fig. 10

- As part of model, postulated nonlinear relationship between output and wage/capital price inflation:

The Phillips Model…

- "We may therefore postulate a relationship between the level of production and the rate of change of *factor* prices, which is probably of the form shown in Fig. 11…" (308)

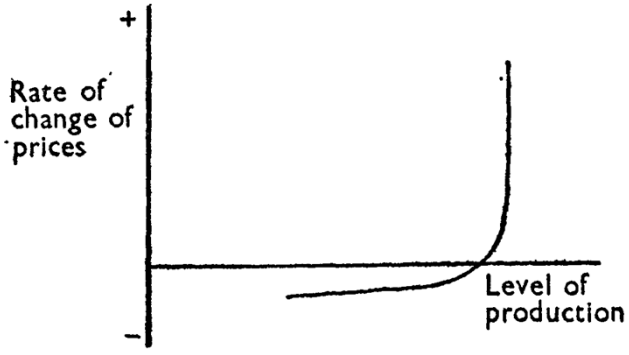


Fig. 11

- Did research that led to Phillips curve to justify this part of his dynamic model, using 19th century UK data…

The Phillips Curve

- Found a "clear tendency" for
  - inverse relation between U and rate of change of money wages (Δw_m)
  - Δw_m above curve when U falling, and vice-versa
- Fitted exponential curve to data:

$$y + a = b.x^c$$

Unemployment

Δw_m

$$\log(y + a) = \log b + c.\log(x)$$

$$\log(y + 0.9) = .984 - 1.394.\log(x)$$

The Phillips Curve

Deviations from trend because of:

Fitted through average wage change & U for 0-2,2-3,3-4, 4-5,5-7,7-11% unemployment

Wage-price spiral due to wars; falling U

Rising unemployment

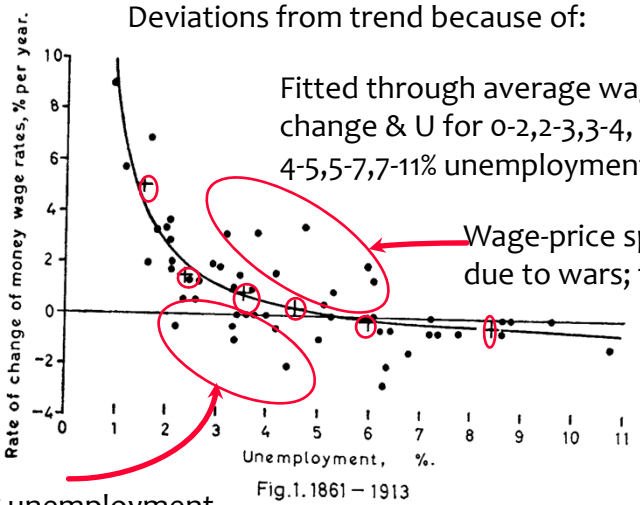


Fig.1. 1861 – 1913

The Phillips Curve fitted to 1913-1948 data

War-induced rise in M prices

Rapid rise in U;
13% fall in M prices;
"cost of living" agreements

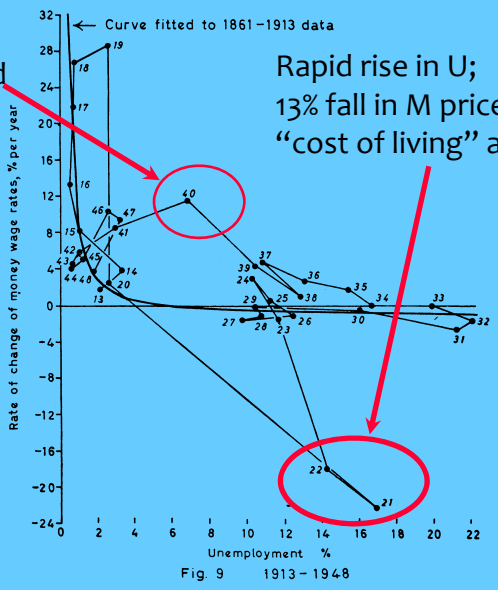


Fig. 9 1913 – 1948

The Phillips Curve

- Economists didn't comprehend Phillips on dynamics
  - Instead, latched onto "trade-off", static interpretation of unemployment-wage rise relationship
  - Can't get static trade-off in dynamic system—Phillips's own point:
    - "It is quite possible that certain types of policy may give rise to undesired fluctuations…" (Phillips 1954: 290)
  - Unfortunately contributed to "trade-off" interpretation of statistical results:
    - "if aggregate demand were kept at a value which would maintain a stable level of product prices the associated level of unemployment would be a little under 2½ per cent. If … demand were kept at a value which would maintain stable wage rates the associated level of unemployment would be about 5½ per cent." (Phillips 1958 p. 299)

The Phillips Curve

- Proposition that policy makers could choose an unemployment-inflation pair became part of orthodox Keynesianism…
  - Unfortunately, *static* relation didn't seem to hold
    - No bloody wonder, we live in a dynamic system!
    - But Keynesian economics discredited by this
- Nonetheless, employment-wage change relation common to all schools of economics
  - Still used in neoclassical static models
  - Here introduced as Phillips intended—as part of dynamic model

Monetary Minsky Model

- First stage: Financial sector

			Assets		Liabilities		Equity
	Account name		Vault	Loans	Firms	Workers	Safe
	Symbol		B_V	F_L	F_D	W_D	B_S
Row	Transaction	Type					
1	Loan	MT	-Loan		Loan		
2	Record Loan	LE		Loan			
3	Compound Debt	LE		Compound			
4	Pay Interest	MT			-Compound		Compound
5	Record Payment	LE		-Compound			
6	Deposit Interest	MT			Dep_F		$-Dep_F$
7	Wages	MT			-Wages	Wages	
8	Deposit Interest	MT				Dep_W	$-Dep_W$
9	Consumption	MT			$Cons_W + Cons_B$	$-Cons_W$	$-Cons_B$
10	Repay Loan	MT	Repay		-Repay		
11	Record Repayment	LR		-Repay			
12	Investment Finance	MT			Invest		
13	Record Finance	LE		Invest			

Monetary Minsky Model

- Generates system of differential equations:

$$\frac{d}{dt}B_V = Repay - Loan$$

$$\frac{d}{dt}F_L = Loan - Repay + Invest$$

$$\frac{d}{dt}F_D = Loan - Repay + Invest - Compound + Dep_F - Wages + Cons_W + Cons_B$$

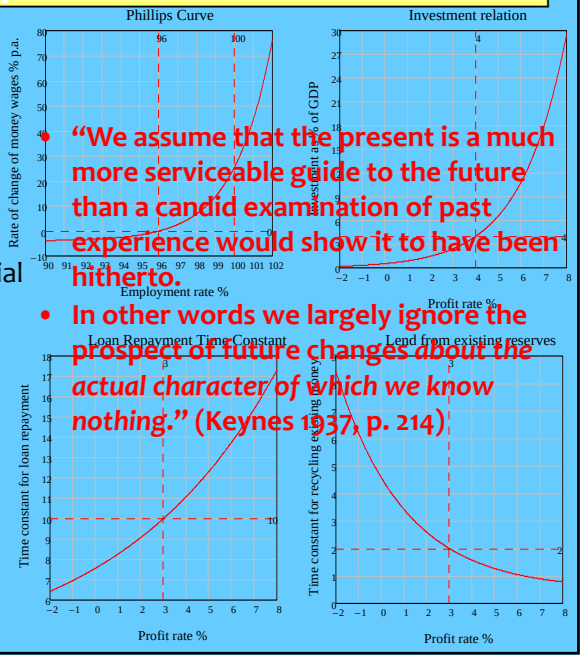
$$\frac{d}{dt}W_D = Wages + Dep_W - Cons_W$$

$$\frac{d}{dt}B_S = Compound - (Dep_F + Dep_W + Cons_B)$$

- Substitutions needed for flow "placeholders"
- Time lags generally used
  - Some constants for simplicity (consumption)
  - Others variables based on current values of profit rate, employment rate
    - Simple nonlinear functional form used…

Monetary model of production

- Keynes's key insight on human behaviour under uncertainty: we extrapolate current conditions
- Nonlinear forms **not** essential
- Nonlinearity inherent in system via multiplication & division of system states
- E.g., Wage bill = Wage rate times employment



- **"We assume that the present is a much more serviceable guide to the future than a candid examination of past experience would show it to have been hitherto.**
- **In other words we largely ignore the prospect of future changes *about the actual character of which we know nothing.*" (Keynes 1937, p. 214)**

Monetary Minsky Model

- Substitutions are:

$$Loan = \frac{B_V}{\tau_L(\pi_r)}$$

$$Compound = r_L \cdot F_L$$

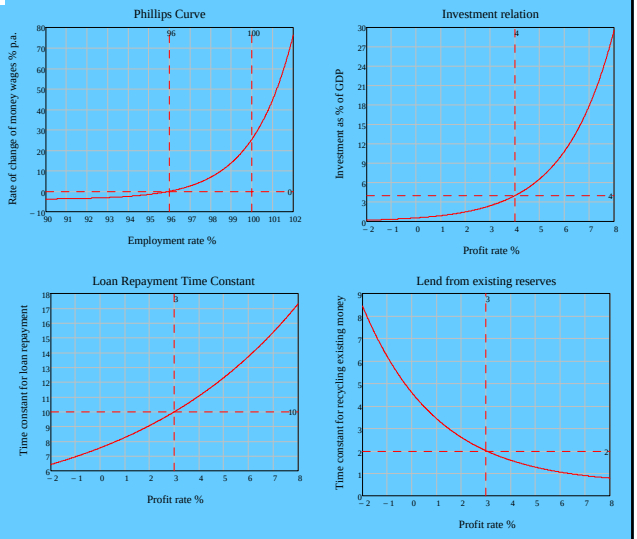
$$Dep_F = r_D \cdot F_D, Dep_W = r_D \cdot W_D$$

$$Wages = W \cdot L$$

$$Cons_W = \frac{W_D}{\tau_W}, Cons_B = \frac{B_S}{\tau_B}$$

$$Repay = \frac{F_L}{\tau_R(\pi_r)}$$

$$Invest = I(\pi_r) \cdot Y$$



Monetary Minsky Model

- Wage change equation a generalised Phillips function:

$$\frac{d}{dt}W = W \cdot \left(P_h(\lambda) + w \cdot \frac{1}{\lambda} \cdot \frac{d}{dt}\lambda + \frac{1}{P} \cdot \frac{d}{dt}P \right), 0 < w < 1$$

- Employment change & price reaction could be lagged
- Price equation as before: lagged convergence to
  - Supply & demand equilibrium
  - Mark up on wage cost of production

$$\frac{dP}{dt} = -\frac{1}{\tau_P} \cdot \left(P - \frac{W}{a \cdot (1-s)} \right)$$

- Production system a Goodwin model
  - Added equations for nominal profit, nominal output…

Monetary Minsky Model

- Full system:

Finance Sector

$$\frac{dB_V}{dt} = \frac{F_L}{\tau_R(\pi_r)} - \frac{B_V}{\tau_L(\pi_r)}$$

$$\frac{dF_L}{dt} = \frac{B_V}{\tau_L(\pi_r)} - \frac{F_L}{\tau_R(\pi_r)} + I(\pi_r)\cdot Y$$

$$\frac{dF_D}{dt} = \frac{B_V}{\tau_L(\pi_r)} - \frac{F_L}{\tau_R(\pi_r)} + I(\pi_r)\cdot Y - r_L\cdot F_L + r_D\cdot F_D - W\cdot L + \frac{W_D}{\tau_W} + \frac{B_S}{\tau_B}$$

$$\frac{dW_D}{dt} = W\cdot L + r_D\cdot W_D - \frac{W_D}{\tau_W}$$

$$\frac{dB_S}{dt} = r_L\cdot F_L - \left(r_D\cdot F_D + r_D\cdot W_D + \frac{B_S}{\tau_B}\right)$$

Prices and Wages

$$\frac{dP}{dt} = -\frac{1}{\tau_P}\cdot\left(P - \frac{W}{a\cdot(1-s)}\right)$$

$$\frac{dW}{dt} = W\cdot\left(P_h(\lambda) + w\cdot\frac{1}{\lambda}\cdot\frac{d}{dt}\lambda + \frac{1}{P}\cdot\frac{d}{dt}P\right)$$

Production

$$Y = P\cdot Y_R$$

$$Y_R = \frac{K_R}{v}$$

$$L = \frac{Y_R}{a}$$

$$\lambda = \frac{L}{N}$$

$$\frac{dK_R}{dt} = K_R\cdot\left(\frac{I(\pi_r)}{v} - \delta\right)$$

$$\pi_r = \frac{Y - W\cdot L - (r_L\cdot F_L - r_D\cdot F_D)}{P\cdot K_R}$$

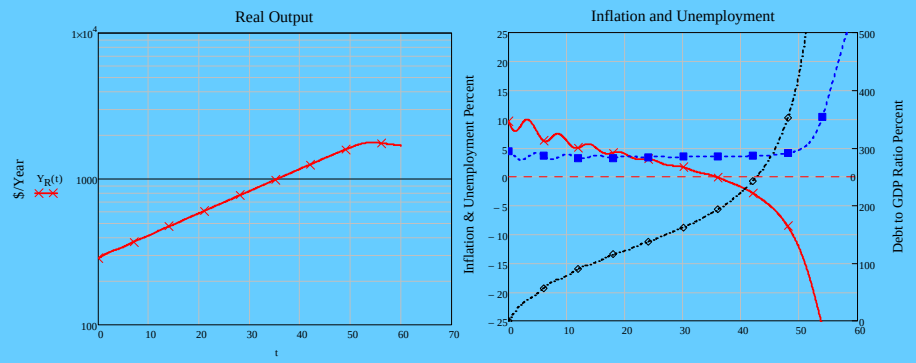
Productivity & *Population*

$$\frac{da}{dt} = \alpha\cdot a$$

$$\frac{dN}{dt} = \beta\cdot N$$

Monetary Minsky Model

- Behavior: "Great Moderation" followed by Great Depression

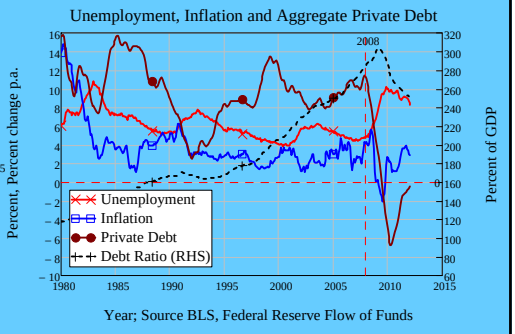


- Many other feasible outcome possible
- But basic "Minskian" insight confirmed:
  - Model can generate Depression
  - Crisis preceded by apparent stabilisation

Monetary Minsky Model

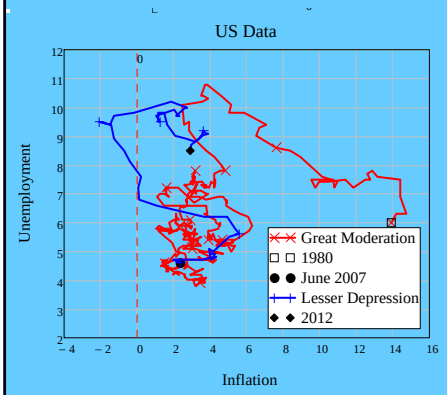
- Evident in empirical data for this crisis
  - From Neoclassical point of view, stability until the crisis hit…

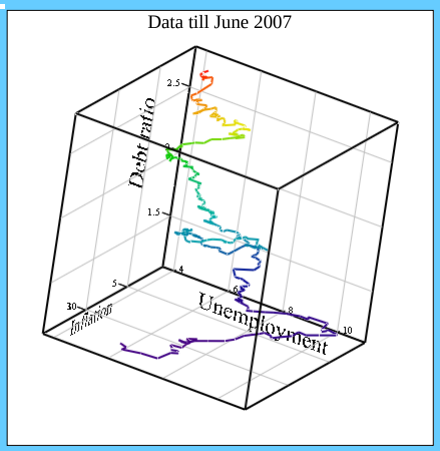
- From Minskian point of view, impending doom



Monetary Minsky Model

- Process more obvious in phase diagram
  - Moderation then inexplicable collapse without debt data:





- Impending collapse obvious with debt data:

Multi-sectoral extension

- Stylized version of monetary flows table:

	Assets				Liabilities		Equity
Account	Bank Reserve	Sector 1 Loan	Sector 2 Loan	Sector 1 Deposit	Sector 2 Deposit	Worker Deposit	Bank Equity
Symbol	$B_R(t)$	$F_{L1}(t)$	$F_{L1}(t)$	$F_{D1}(t)$	$F_{D2}(t)$	$W_D(t)$	$B_E(t)$
Compound Debt		A_1	A_2				
Deposit Interest				B_1	B_2		
Wages				$-C_1$	$-C_2$	C_1+C_2	
Worker Interest						-D	-D
Investment K				E	-E		
Intersectoral C				-F	F		
Intersectoral A				-G	G		
Intersectoral E				-H	H		
Consumption K				I	-I		
Consumption C				-J	J		
Consumption A				-K	K		
Consumption E				-L	L		
Pay Interest				-M			M
Repay Loans	N			-N			
Recycle Reserves	-O	O		O			
New Money		P		P			

Multi-sectoral extension

- Non-parsimonious, "meteorological" model: 40 ODEs

$$\frac{d}{dt}B_R(t) = \frac{F_{LA1}(t)}{\tau_{RL}(pr_A(t))} - \frac{2\cdot B_R(t)}{\tau_{RR}(pr_C(t))} - \frac{2\cdot B_R(t)}{\tau_{RR}(pr_E(t))} - \frac{2\cdot B_R(t)}{\tau_{RR}(pr_K(t))} - \frac{2\cdot B_R(t)}{\tau_{RR}(pr_A(t))} + \frac{F_{LA2}(t)}{\tau_{RL}(pr_A(t))} + \frac{F_{LC1}(t)}{\tau_{RL}(pr_C(t))} + \frac{F_{LC2}(t)}{\tau_{RL}(pr_C(t))} + \frac{F_{LE1}(t)}{\tau_{RL}(pr_E(t))} + \frac{F_{LE2}(t)}{\tau_{RL}(pr_E(t))} + \frac{F}{\tau_R}$$

$$\frac{d}{dt}F_{LK1}(t) = \frac{B_R(t)}{\tau_{RR}(pr_K(t))} - \frac{F_{LK1}(t)}{\tau_{RL}(pr_K(t))} + \frac{F_{LK1}(t)}{\tau_{NM}(pr_K(t))}$$

$$\frac{d}{dt}F_{LK2}(t) = \frac{B_R(t)}{\tau_{RR}(pr_K(t))} - \frac{F_{LK2}(t)}{\tau_{RL}(pr_K(t))} + \frac{F_{LK2}(t)}{\tau_{NM}(pr_K(t))}$$

$$\frac{d}{dt}F_{LC1}(t) = \frac{B_R(t)}{\tau_{RR}(pr_C(t))} - \frac{F_{LC1}(t)}{\tau_{RL}(pr_C(t))} + \frac{F_{LC1}(t)}{\tau_{NM}(pr_C(t))}$$

$$\frac{d}{dt}F_{LC2}(t) = \frac{B_R(t)}{\tau_{RR}(pr_C(t))} - \frac{F_{LC2}(t)}{\tau_{RL}(pr_C(t))} + \frac{F_{LC2}(t)}{\tau_{NM}(pr_C(t))}$$

$$\frac{d}{dt}F_{LA1}(t) = \frac{B_R(t)}{\tau_{RR}(pr_A(t))} - \frac{F_{LA1}(t)}{\tau_{RL}(pr_A(t))} + \frac{F_{LA1}(t)}{\tau_{NM}(pr_A(t))}$$

$$\frac{d}{dt}F_{LA2}(t) = \frac{B_R(t)}{\tau_{RR}(pr_A(t))} - \frac{F_{LA2}(t)}{\tau_{RL}(pr_A(t))} + \frac{F_{LA2}(t)}{\tau_{NM}(pr_A(t))}$$

$$\frac{d}{dt}F_{LE1}(t) = \frac{B_R(t)}{\tau_{RR}(pr_E(t))} - \frac{F_{LE1}(t)}{\tau_{RL}(pr_E(t))} + \frac{F_{LE1}(t)}{\tau_{NM}(pr_E(t))}$$

$$\frac{d}{dt}F_{LE2}(t) = \frac{B_R(t)}{\tau_{RR}(pr_E(t))} - \frac{F_{LE2}(t)}{\tau_{RL}(pr_E(t))} + \frac{F_{LE2}(t)}{\tau_{NM}(pr_E(t))}$$

$$\frac{d}{dt}[illegible] = \frac{B_R(t)}{[illegible]} [illegible] F_{DA1}(t) \quad F_{DC1}(t) \quad F_{DE1}(t) \quad F_{DK1}(t) \quad F_{DK2}(t) \quad F_{LK1}(t) \quad F_{LK1}(t) \quad B_E$$

Multi-sectoral extension

- Profit now net of intersectoral input purchases:

$$\frac{\Pi_K(t) = P_K(t)\cdot Q_K(t) - W(t)\cdot L_K(t) - \sum_{S\neq K}^{n}\left(\sigma_{KS}\cdot W(t)\cdot L_S(t)\right) - \left(r_L\cdot K_L(t) - r_D K_D(t)\right)}{P_K(t)\cdot K_K(t)}$$

$$\frac{\Pi_C(t) = P_C(t)\cdot Q_C(t) - W(t)\cdot L_C(t) - \sum_{S\neq C}^{n}\left(\sigma_{CS}\cdot W(t)\cdot L_S(t)\right) - \left(r_L\cdot C_L(t) - r_D C_D(t)\right)}{P_K(t)\cdot K_C(t)}$$

- Each sector modeled as Goodwin cycle

$$\frac{d}{dt}K_C(t) = \frac{F_{DK}(t)}{\tau_{PR}\left(\pi_C(t)\right)\cdot P_K(t)} - \gamma K_C(t) \qquad \text{Capital Stock}$$

$$\frac{d}{dt}Q_C(t) = -\frac{1}{\tau_{QC}}\cdot\left(Q_C(t) - \frac{1}{v_C}\cdot K_C(t)\right) \qquad \text{Output}$$

$$\frac{d}{dt}L_C(t) = -\frac{1}{\tau_{LC}}\cdot\left(L_C(t) - \frac{1}{a_C(t)}\cdot Q_C(t)\right) \qquad \text{Labor}$$

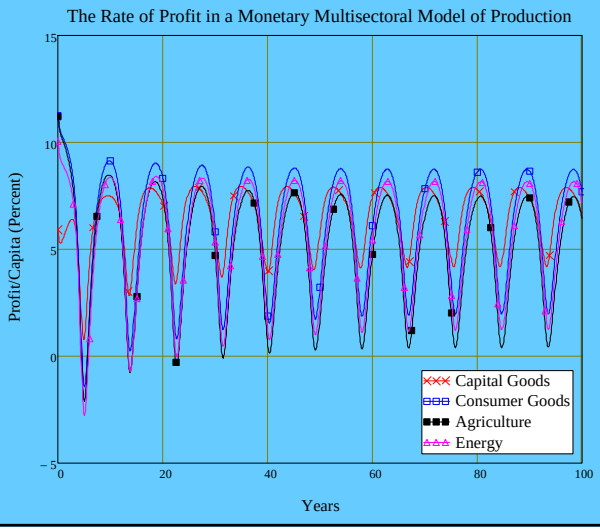
$$\frac{d}{dt}P_C(t) = -\frac{1}{\tau_{PC}}\cdot\left(P_C(t) - \frac{W(t)}{a_C(t)\cdot(1-s_C)}\right) \qquad \text{Price Level}$$

$$\frac{d}{dt}a_C(t) = \alpha\cdot a_C(t) \qquad \text{Labor Productivity}$$

- Financial flows matrix captures intersectoral dependencies

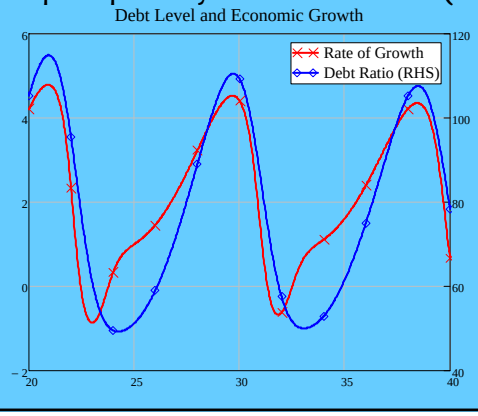
Multi-sectoral extension

- "*Conjecture*: The repeated development of an unstable state of the economy is … an unavoidable consequence of, the local instability of the state of balanced growth." (Blatt 1983, p. 161)



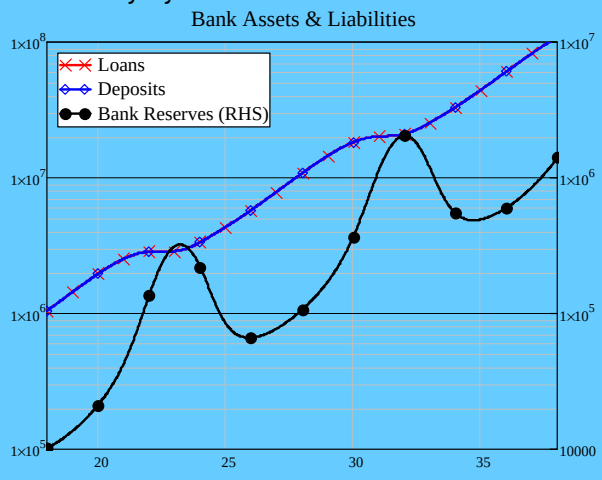
Multi-sectoral extension

- "The usual image of the business cycle was of a wavelike movement, and the waves of the sea were the accepted metaphor… The reality in the nineteenth and early twentieth centuries was, in fact, much closer to the teeth of a ripsaw which go up on a gradual plane on one side and drop precipitately on the other…" (Galbraith 1975, p. 104)



Multi-sectoral extension

- Model fundamentally monetary: physical cycles cause and caused by cycles in finance



References

- Bernanke, B. S. (2000). Essays on the Great Depression. Princeton, Princeton University Press.
- Bernanke, B. S. (2004). "Panel discussion: What Have We Learned Since October 1979?" Conference on Reflections on Monetary Policy 25 Years after October 1979, St. Louis, Missouri, Federal Reserve Bank of St. Louis.
- Blatt, J. M. (1983). Dynamic economic systems: a post-Keynesian approach. Armonk, N.Y, M.E. Sharpe.
- Cotis, J.-P. (2007). Editorial: Achieving Further Rebalancing. OECD Economic Outlook. OECD. Paris, OECD. 2007/1: 7-10.
- Fisher, I. (1933). "The Debt-Deflation Theory of Great Depressions." Econometrica 1(4): 337-357.
- Keen, S. (1995). "Finance and Economic Breakdown: Modeling Minsky's 'Financial Instability Hypothesis.'." Journal of Post Keynesian Economics **17**(4): 607-635.
- Keen, S. "A monetary Minsky model of the Great Moderation and the Great Recession." Journal of Economic Behavior & Organization (forthcoming).
- Keynes, J. M. (1937). "The General Theory of Employment." The Quarterly Journal of Economics 51(2): 209-223.
- Krugman, P. and G. B. Eggertsson (2010). Debt, Deleveraging, and the Liquidity Trap: A Fisher-Minsky-Koo approach [2nd draft 2/14/2011]. New York, Federal Reserve Bank of New York & Princeton University.
- Kümmel, R., R. U. Ayres, et al. (2010). "Thermodynamic laws, economic methods and the productive power of energy." Journal of Non-Equilibrium Thermodynamics 35: 145-179.
- Marx, K. (1858 [1993]). Grundrisse: Foundations of the Critique of Political Economy. London, Penguin Classics.
- Minsky, H. P. (1982). Can "it" happen again? : essays on instability and finance. Armonk, N.Y., M.E. Sharpe.
- Phillips, A. W. (1954). "Stabilisation Policy in a Closed Economy." The Economic Journal 64(254): 290-323.
- Phillips, A. W. (1958). "The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957." Economica 25(100): 283-299.
- Schumpeter, J. A. (1934). The theory of economic development : an inquiry into profits, capital, credit, interest and the business cycle. Cambridge, Massachusetts, Harvard University Press.
- Sraffa, P. (1926). "The Laws of Returns under Competitive Conditions." The Economic Journal 36(144): 535-550.
- Sraffa, P. (1960). Production of commodities by means of commodities :prelude to a critique of economic theory. Cambridge, Cambridge University Press.